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MS-113

project
mercury

OPERATION AND MAINTENANCE

ACQUISITION SYSTEM ATLANTIC SHIP INDIAN OCEAN SHIP

prepared for
National Aeronautics and Space Administration
Contract No. NAS 1-430

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The Bendix Corporation
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in association with

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WARNING

The equipment described in this manual employs voltages which are dangerous. Use appropriate caution when working on this equipment.

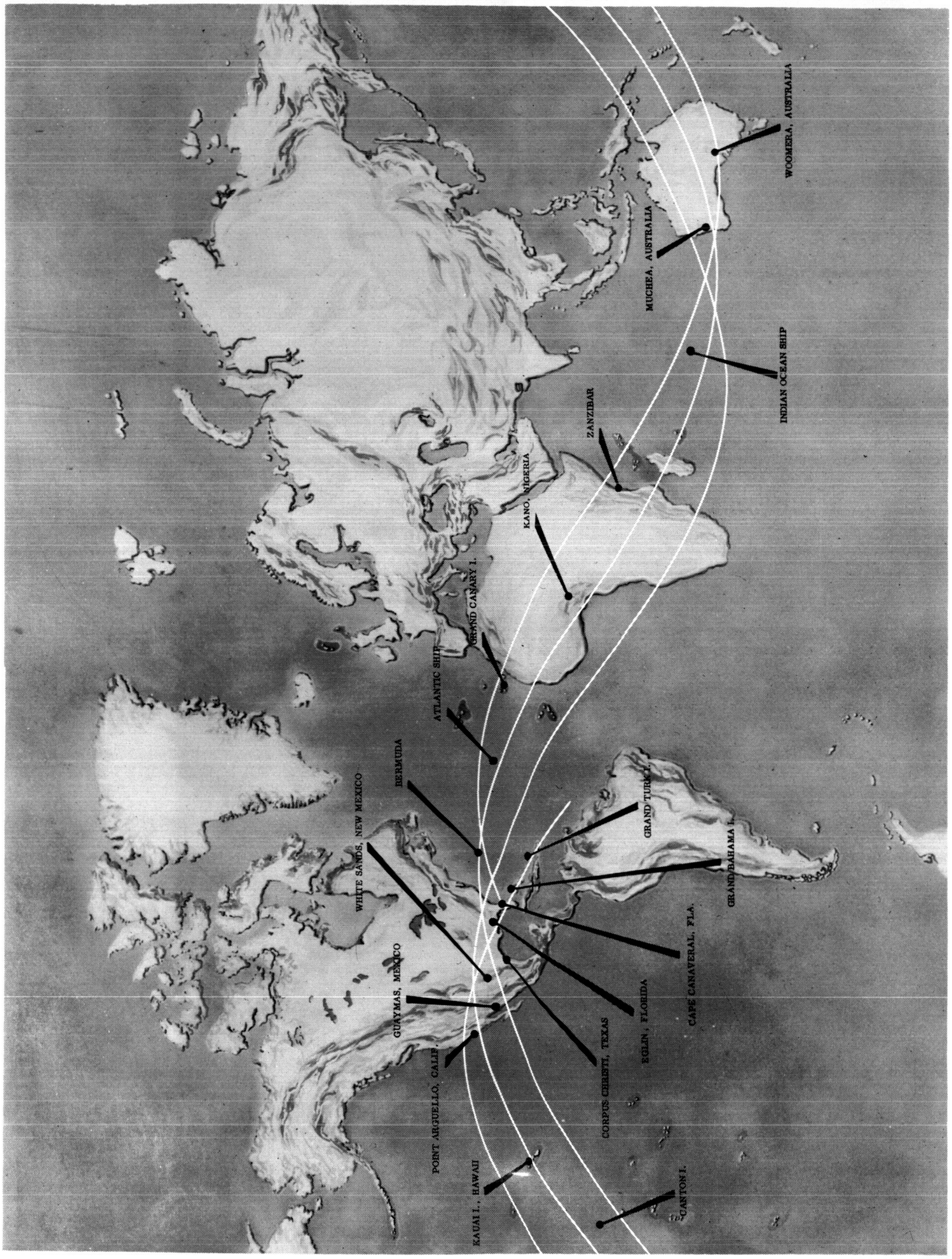


Figure 1-1. Locations of Project Mercury Sites

SECTION I
GENERAL DESCRIPTION

1-1. GENERAL INFORMATION

A. SCOPE OF MANUAL

This publication comprises operating and service instructions for the acquisition system which forms a part of the Mercury ground instrumentation on the Atlantic and Indian Ocean Ships. Except as otherwise noted, the information contained herein applies to both ships.

B. PROJECT MERCURY SCOPE

(1). The prime objective of Project Mercury is manned orbital flight with a safe return of the man from orbit. The manned vehicle or satellite that is placed into orbit is called the capsule, and the individual making the orbital flight is called the astronaut.

(2). A launch vehicle with a radio-inertial guidance system will be used to place the capsule into orbit. The launch will be from Cape Canaveral, Florida with launch azimuth slightly north of east (inclined 32.5 degrees to the equator) and nominal orbit insertion point approximately 410 nautical miles from Cape Canaveral. The planned orbit will have a period of 88 minutes and will be at an altitude of 105 $\pm$5 nautical miles.

(3). Initially, the orbital flights will each consist of three orbital cycles with a water landing west of Puerto Rico. In the event of in-flight emergency, backup systems are provided in the capsule to permit the flight to continue until the next passage over the eastern United States. Emergency landings at the completion of one orbit can be made in the Atlantic off of Charleston, South Carolina or near Bermuda. At the end of the second passage, the emergency landing area is in the Atlantic off of Charleston, South Carolina. If a malfunction occurs during the early launch phase, emergency procedures will permit a water landing off of Cape Canaveral. Controlled retro firing will be used to contain most of the abort impact areas near Bermuda or in the vicinity of the Canary Islands.

(4). To implement Project Mercury, a world-wide network of 18 ground-based tracking and instrumentation sites has been established together with a control center and a computing and communications center. Eleven of these sites are equipped with long range tracking radars; these comprise the tracking network. Sixteen sites have telemetry receiving and display equipment. Six of these sites are equipped to transmit command control signals to the capsule; these are known as command sites. Sixteen of the sites are equipped with capsule communication equipment that provides two-way voice contact with the astronaut. In addition, all of the sites are linked with the computing and control centers by a ground communication network. See figure 1-1 for the location of the sites.

C. SITE FUNCTIONS

From orbit insertion until landing, the tracking and ground instrumentation systems will provide continuous prediction of the capsule location; they will monitor the status of the capsule and astronaut; and they will permit the command functions necessary for the mission. The functions of the tracking and ground instrumentation systems are completed when the capsule has landed and the best possible information on the landing point location has been supplied to a recovery team. Table 1-I lists the various sites and functions of each

D. SYSTEM FUNCTIONS

The function of the acquisition system is to supply pointing data (capsule azimuth and elevation) to the active acquisition aid antenna and the transmitting and receiving antenna.

1-2. EQUIPMENT SUPPLIED

Table 1-II lists the equipment supplied for the acquisition system. A number of items of test equipment shown in this table are also used for other systems on the site. Such items are listed in the applicable manuals of the other systems as well as in this manual.

TABLE 1-I. FUNCTIONS OF EACH SITE

Site	S-Band Radar Tracking	C-Band Radar Tracking	Telemetry and Capsule Communications	Command Control
Cape Canaveral, Florida	X	X	X	X
Grand Bahama Island	—	—	X	—
Grand Turk Island	—	—	X	—
Bermuda	X	X	X	X
Atlantic Ship	—	—	X	—
Grand Canary Island	X	—	X	—
Kano, Nigeria	—	—	X	—
Zanzibar	—	—	X	—
Indian Ocean Ship	—	—	X	—
Muchea, Australia	X	—	X	X
Woomera, Australia	—	X	X	—
Canton Island	—	—	X	—
Kauai Island, Hawaii	X	X	X	X
Point Arguello, California	X	X	X	X
Guaymas, Mexico	X	—	X	X
White Sands, New Mexico	—	X	—	—
Corpus Christi, Texas	X	—	X	—
Eglin, Florida	X	X	—	—

TABLE 1-II. EQUIPMENT SUPPLIED

Equipment	Manufacturer	Model	Qty	Instruction Book Inventory Number and Title
OPERATING EQUIPMENT				
Acquisition Data Console	The Bendix Corporation Bendix Radio Division	R6514499-3	1	MS-113, Acquisition System Manual—Operation & Maintenance—Atlantic Ship and Indian Ocean Ship
Active Acquisition Aid each consisting of:	Cubic Corporation	—	2	ME-129, Instruction Manual for Active Acquisition Aid (AGAVE)
Triplexer (Multiplexer)	—	—	1	—
Diplexer (Multiplexer)	—	—	2	—
RF Housing	—	—	1	—
Amplidyne	—	—	2	—
Receiver Cabinet	—	—	1	—
Servo Cabinet	—	—	1	—
Control Console	—	—	1	—
Boresight Antenna & Transmitter	—	—	1	—
Antenna and Pedestal consisting of:	—	—	1	—
Quad-Helix Array	—	—	1	—
HF Dipole and Reflector	—	—	1	—
Ground Planes	—	—	1	—
Hybrid Ring	—	—	4	—
Pedestal	—	—	1	—

TABLE 1-II. EQUIPMENT SUPPLIED (Cont.)

Equipment	Manufacturer	Model	Qty	Instruction Book Inventory Number and Title
OPERATING EQUIPMENT (Cont.)				
Antenna Drive Power Cutoff Switch and Warning Light	The Bendix Corporation Bendix Radio Division	L653858-1	1	MS-113, Acquisition System Manual—Operation and Maintenance—Atlantic Ship and Indian Ocean Ship
TEST EQUIPMENT				
Oscilloscope	Hewlett-Packard Company	130B	1	ME-200, Operating and Servicing Manual, Model 130B/BR Oscilloscope
Oscilloscope	Tektronix, Incorporated	545A	1	ME-202, Instruction Manual, Type 535A, Type 545A, Cathode-Ray Oscilloscopes
Dual-Trace Calibrated Preamplifier	Tektronix, Incorporated	Type CA	1	ME-203, Instruction Manual, Type CA Plug-In Unit
Plug-In Preamplifier	Tektronix, Incorporated	Type L	1	ME-136, Instruction Manual, Type L Plug-In Unit
Viewing Hood	Tektronix, Incorporated	H510	1	ME-202, Instruction Manual, Type 535A, Type 545A, Cathode-Ray Oscilloscopes (Accessories Section)
Oscilloscope Cart	Technibilt Corporation	OC-2 (Bendix Radio - Part A683940-2)	1	—
Oscilloscope Cart	Technibilt Corporation	OC-2 (Bendix Radio - Part A683940-1)	1	—
Unit Regulated Power Supply	General Radio Company	1201-B	1	ME-211, Operating Instructions, Type 1201-B Unit Regulated Power Supply
Regulated Power Supply	Lambda Electronics Corporation	71	1	ME-138, Instruction Manual, Lambda Regulated Power Supply Model 71

TABLE 1-II. EQUIPMENT SUPPLIED (Cont.)

Equipment	Manufacturer	Model	Qty.	Instruction Book Inventory Number and Title
TEST EQUIPMENT (Cont.)				
DC Power Supply	John Fluke Manufacturing Company, Incorporated	407	1	ME-231, Instruction Manual, Model 407 DC Power Supply
Square Wave Generator	Tektronix, Incorporated	Type 105	1	ME-230, Instruction Manual, Square Wave Generator Type 105
Signal Generator	Boonton Radio Corporation	225-A	1	ME-188, Instruction Manual, Signal Generator Type 225-A
Sweep Generator	Telonic Industries, Incorporated	HN-3	1	ME-120, Operating Instruction Manual
HF Signal Generator	Hewlett-Packard Company	606-A	1	ME-189, Operating and Servicing Manual
Function Generator	Hewlett-Packard Company	202-A	1	ME-205, Operating and Servicing Manual
Transfer Oscillator	Hewlett-Packard Company	540-B	1	ME-232, Operating and Servicing Manual
Wide Range Oscillator	Hewlett-Packard Company	200 CD	1	ME-198, Operating and Servicing Manual
Unit Oscillator	General Radio Company	1209-BL	1	ME-212, Operating Instructions, Types 1209-B and BL Unit Oscillators
Universal EPUT and Timer	Beckman Instruments, Incorporated	7370	1	ME-196, Instruction Manual, Model 7370 Universal EPUT and Timer
Frequency Converter	Beckman Instruments, Incorporated	7570 through 7573	1	ME-197, Instruction Manual, Model 7570 Series Frequency Conversion Equipment
Field Strength Meter	Empire Devices Products Corporation	NF-105 (Bendix Part No.A683351)	1	ME-192, Instruction Manual for Noise and Field Intensity Meter
Power Output Meter	The Daven Company	OP-962	1	ME-154, Instruction Manual
Potentiometric DC Voltmeter	John Fluke Manufacturing Company, Incorporated	801	1	ME-118, Instruction Manual, Model 801 Potentiometric DC Voltmeter
Vacuum Tube Voltmeter	Hewlett-Packard Company	410B	2	ME-190, Operating and Servicing Manual

TABLE 1-II. EQUIPMENT SUPPLIED (Cont.)

Equipment	Manufacturer	Model	Qty.	Instruction Book Inventory Number and Title
TEST EQUIPMENT (Cont.)				
Vacuum Tube Voltmeter	Hewlett-Packard Company	400D	2	ME-191, Operating and Servicing Manual 400D/H/L Vacuum Tube Voltmeter
Volt-Ohm-Milliammeter	Triplett Electrical Instrument Company	630-PL	3	ME-193, Instruction Manual, Model 630-PL Volt-Ohm-Milliammeter
Noise and Distortion Analyzer	Hewlett-Packard Company	330B	1	ME-194, Operating and Servicing Manual, 330B/C/D Noise and Distortion Analyzer
RF Detector	Telonic Industries, Incorporated	XD-3	2	ME-135, Instruction Manual
Tube Analyzer	Triplett Electrical Instrument Company	3444	1	ME-199, Instruction Manual, Model 3444 Tube Analyzer
Variac	General Radio Company	W10MT	1	ME-246, Operating Instructions for W10 Variac
Attenuator Pad	Telonic Industries, Incorporated	TGC-50	2	—
Miscellaneous Cables and Accessories	—	—	—	—

1-3. DESCRIPTION OF ACQUISITION SYSTEM

A. GENERAL

(1). The major components of the acquisition systems on the Atlantic and Indian Ocean Ships are an acquisition data console and an active acquisition aid. Each of these units and systems is described in the following paragraphs. Additional equipment in the system includes an antenna drive power cut-off switch and warning light.

B. PHYSICAL DESCRIPTION

The following paragraphs give a physical description of the equipment on the two ships covered in this manual.

(1). ACQUISITION DATA CONSOLE (Figure 1-2)

The acquisition data console consists of a rack, 59-5/8 inches high, 23-9/16 inches wide, and 22 inches deep, on which are mounted several panels. It is bolted to the active acquisition aid control console, as shown in figure 1-2. A common writing surface extends 18-1/2 inches from the front of both consoles. Omitting blanks and starting from the top, the panels on the acquisition data console are an intercom panel, an acquisition data panel, and a dual power supply. A relay chassis is mounted inside the console on the right side near the acquisition data panel. The intercom panel is not functionally a part of the acquisition data console; for information on it, refer to the Intrasite PBX and Intercom System Manual, MS-109.

(a). ACQUISITION DATA PANEL

The acquisition data panel is made up of displays, indicators, and controls.

1. Across the top of the panel there are four signal strength meters, four indicator lamps, and four meter calibration potentiometers. One indicator lamp and one potentiometer is associated with each meter.

2. In the center of the panel there are six synchro displays. The top two are differential receivers; the one on the left displays the true azimuth of the active acquisition aid antenna, and the one on the right displays the true azimuth of the transmitting and receiving antenna. The center pair and the bottom pair of displays are synchro receivers (not the same as synchro

differential receivers). The left one of the center pair displays the elevation of the active acquisition aid antenna, and the right one the elevation of the transmitting and receiving antenna. The left one of the bottom pair displays the active acquisition aid antenna relative azimuth, and the right one the transmitting and receiving antenna relative azimuth.

3. Next to each of the relative azimuth displays there is a pair of lamps which indicate the azimuth position of the antennas relative to the limits of cable wrap.

4. Just below the transmitting and receiving antenna relative azimuth display is a double indicator, the top half is labeled "SLAVED" (green when lit) and the bottom half "MANUAL" (red when lit).

5. Two switches are on the left side of the panel adjacent to the active acquisition aid antenna elevation display. Both of these switches are labeled "28V SUPPLY". They are either red or green when lit.

(b). <u>DUAL POWER SUPPLY</u>

Four chassis, together with the relay chassis described below, make up two 28 VDC power supplies. Each power supply has a transformer, a silicon bridge rectifier, a fuse, and two filter capacitors on one chassis, and a filter choke and three filter capacitors on a second chassis. The dual power supply panel provides mounting for the four chassis. On the front of the panel are an off-on switch, which controls the primary power to both power supplies, a power-on indicator, and four line fuses — two for each power supply — in indicating-type holders.

(c). <u>RELAY CHASSIS</u>

The relay chassis provides mounting for two relays and two zener diodes which make up control circuitry for the 28 VDC power supplies.

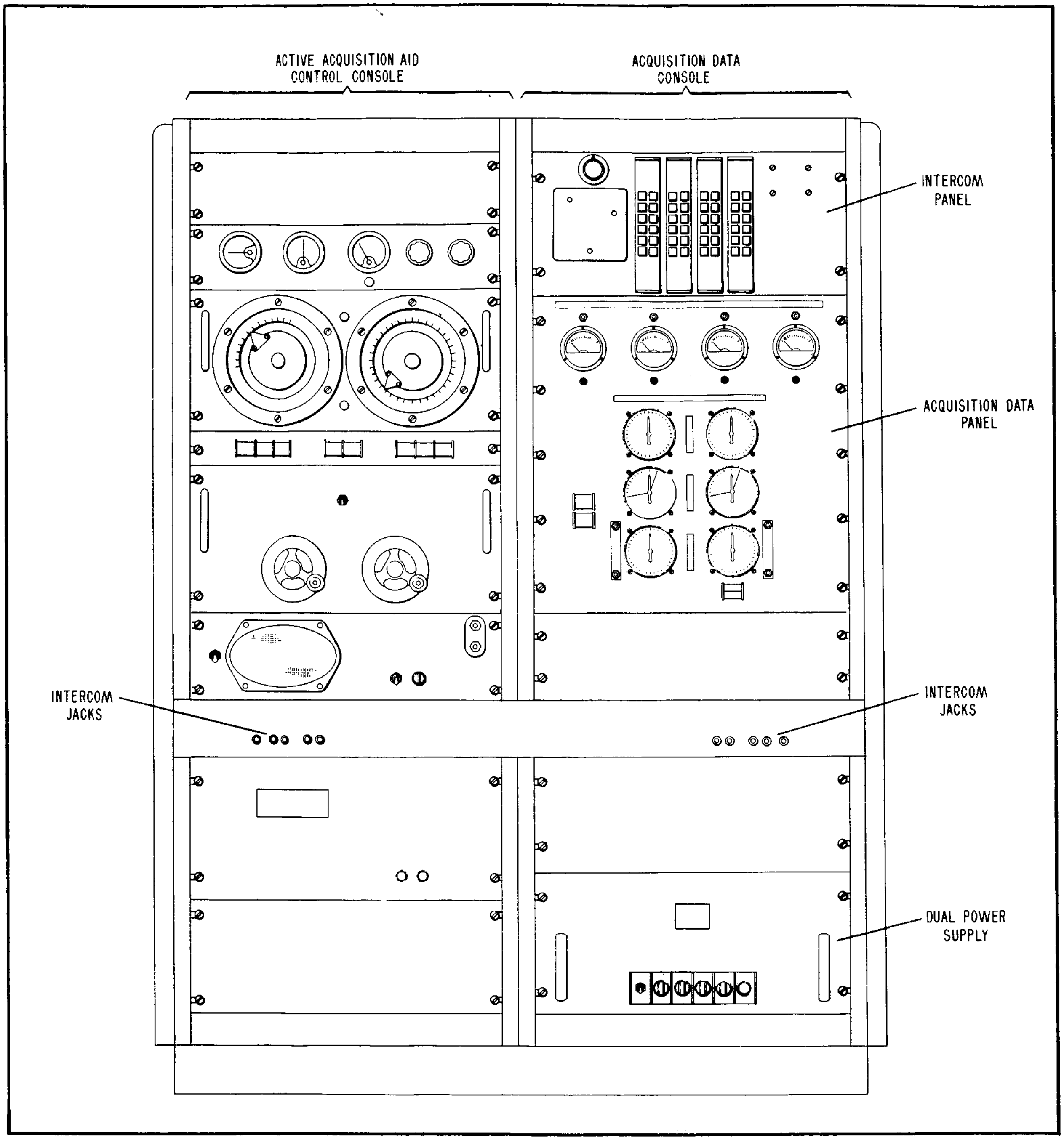


Figure 1-2. Acquisition Data Console and Active Acquisition Aid Control Console

(2). ACTIVE ACQUISITION AID (Figures 1-2 through 1-9)

The active acquisition aid, which is a system in itself, comprises eleven major units or assemblies: a control console, a receiver cabinet, a servo cabinet, an antenna and pedestal, two amplidynes, two diplexers, a triplexer, and RF housing, and a boresight antenna and transmitter.

(a). The control console (shown along with the acquisition data console in figure 1-2) has the same over-all dimensions as the acquisition data console, to which it is bolted. Like the acquisition data console, the active acquisition aid control console consists of a rack in which are mounted a number of panels. On these panels are controls, indicators, and switches for the operation of the active acquisition aid.

(b). The receiver cabinet contains the circuits of the active acquisition aid which develop the error signals used to position the antenna for tracking. The receiver cabinet is 23-9/16 inches wide, 22 inches deep, and 77 inches high. It is bolted to the servo cabinet. (See figure 1-3.)

(c). The servo cabinet (figure 1-3) houses components of the servo system which positions the antenna in azimuth and elevation. Its over-all physical dimensions are the same as those of the receiver cabinet, to which it is bolted.

(d). The active acquisition aid antenna and pedestal (figure 1-4) includes a quad-helix array, an HF dipole and reflector, ground planes, four hybrid rings, and the pedestal itself.

(e). For physical descriptions of the amplidynes, diplexers, triplexer, RF housing, and boresight antenna and transmitter (figures 1-5 through 1-9) and for complete physical descriptions of the control console, receiver cabinet, servo cabinet, and antenna and pedestal, see the applicable equipment manual, listed in table 1-II.

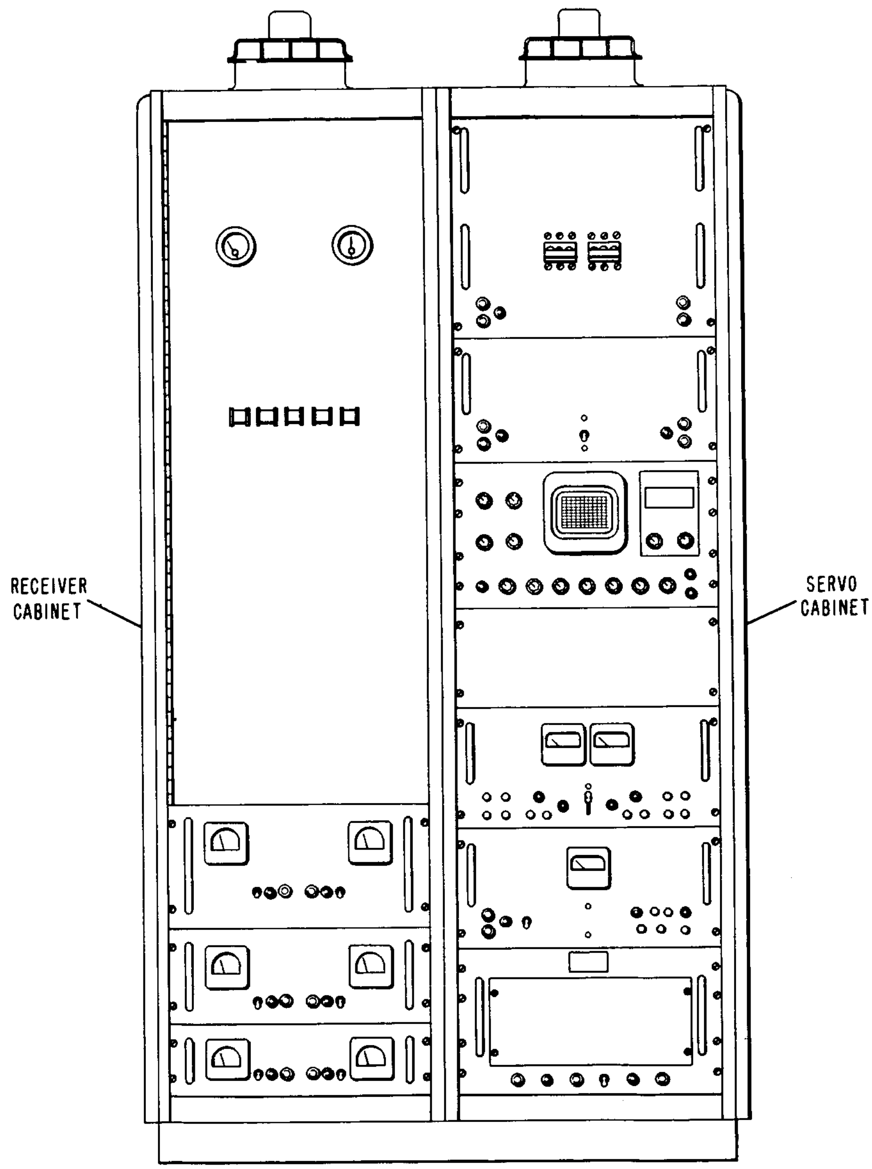


Figure 1-3. Active Acquisition Aid Receiver Cabinet and Servo Cabinet

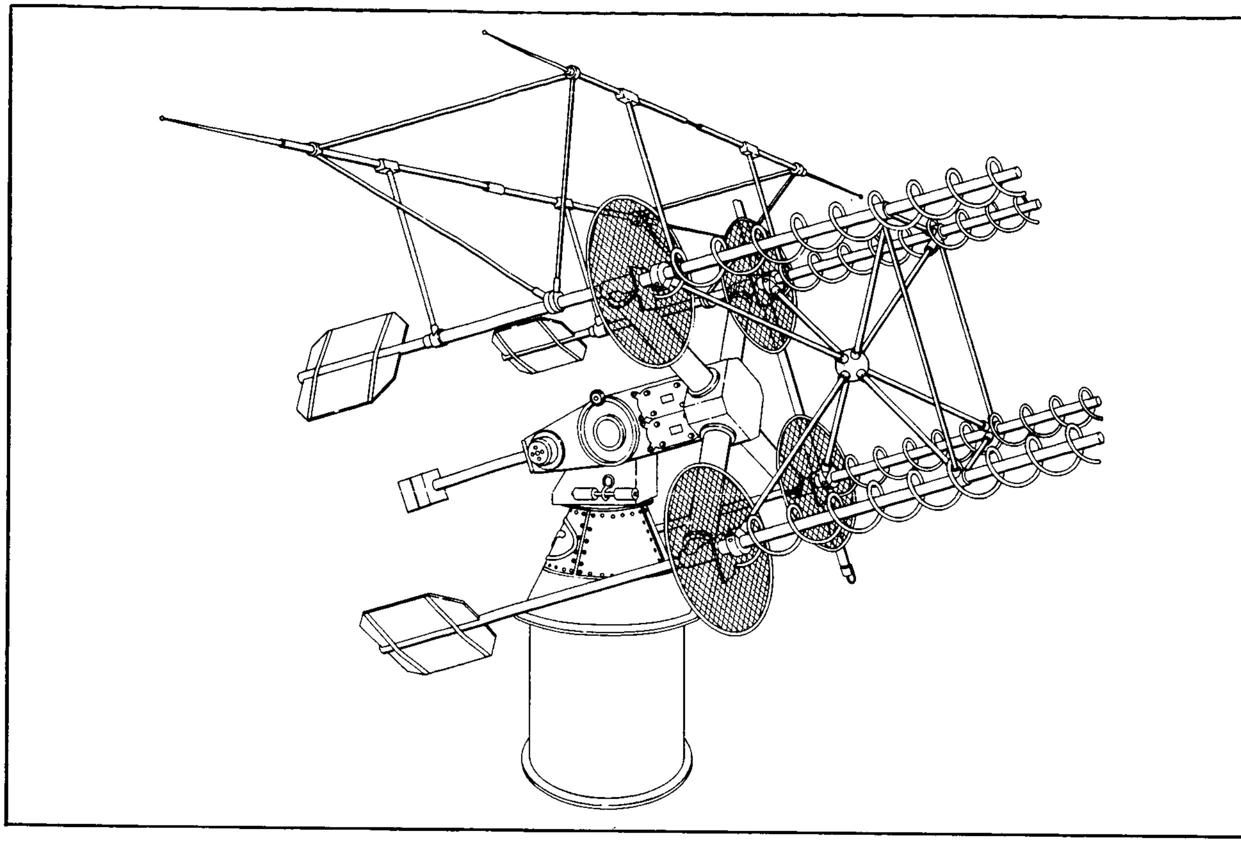


Figure 1-4. Active Acquisition Aid Antenna and Pedestal

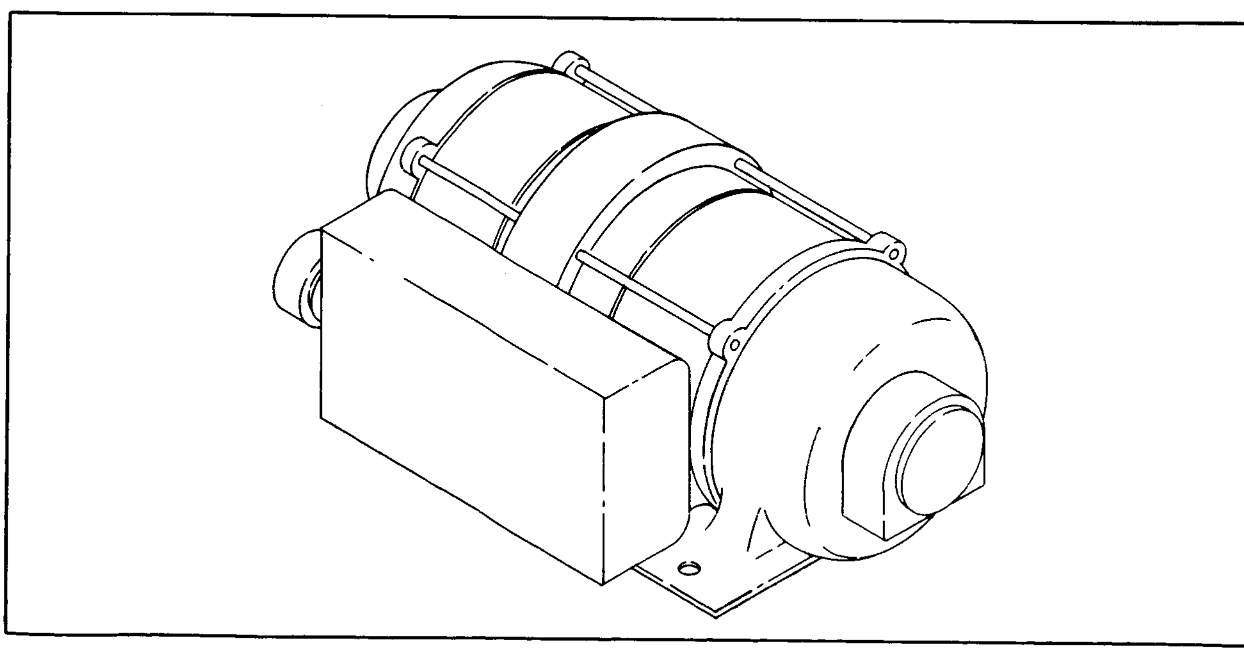


Figure 1-5. Active Acquisition Aid Amplidyne

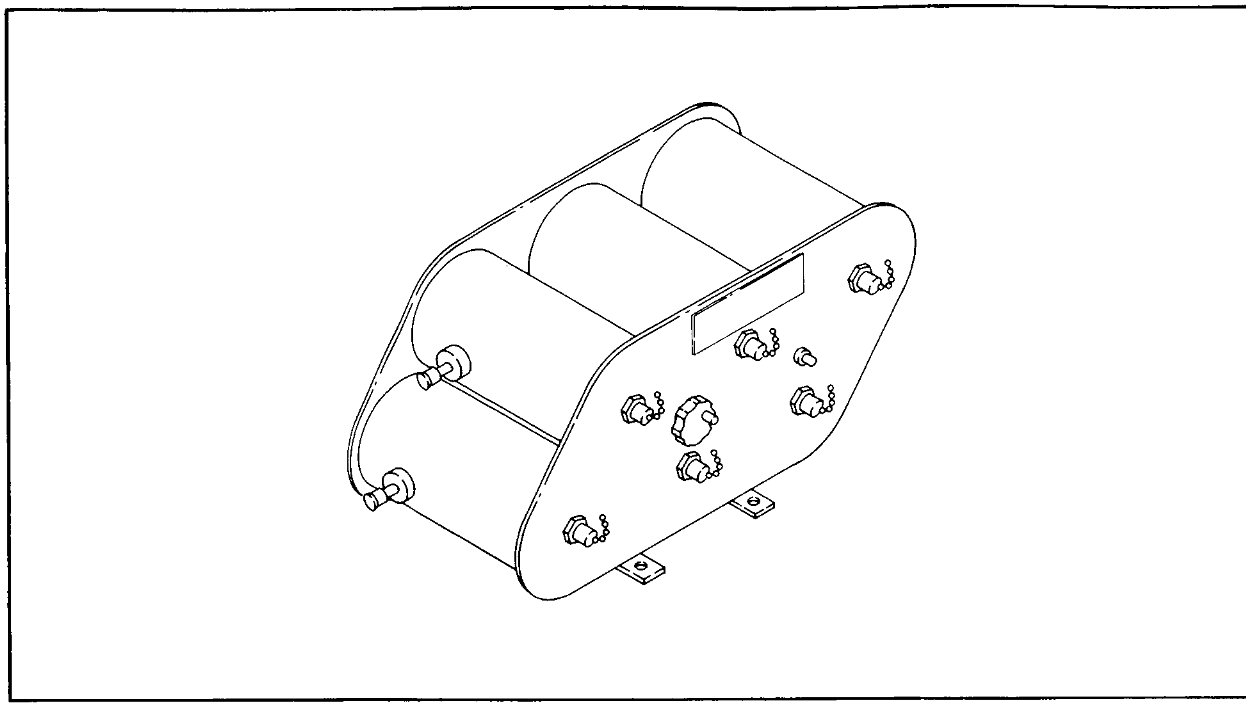


Figure 1-6. Active Acquisition Aid Diplexer (Multiplexer)

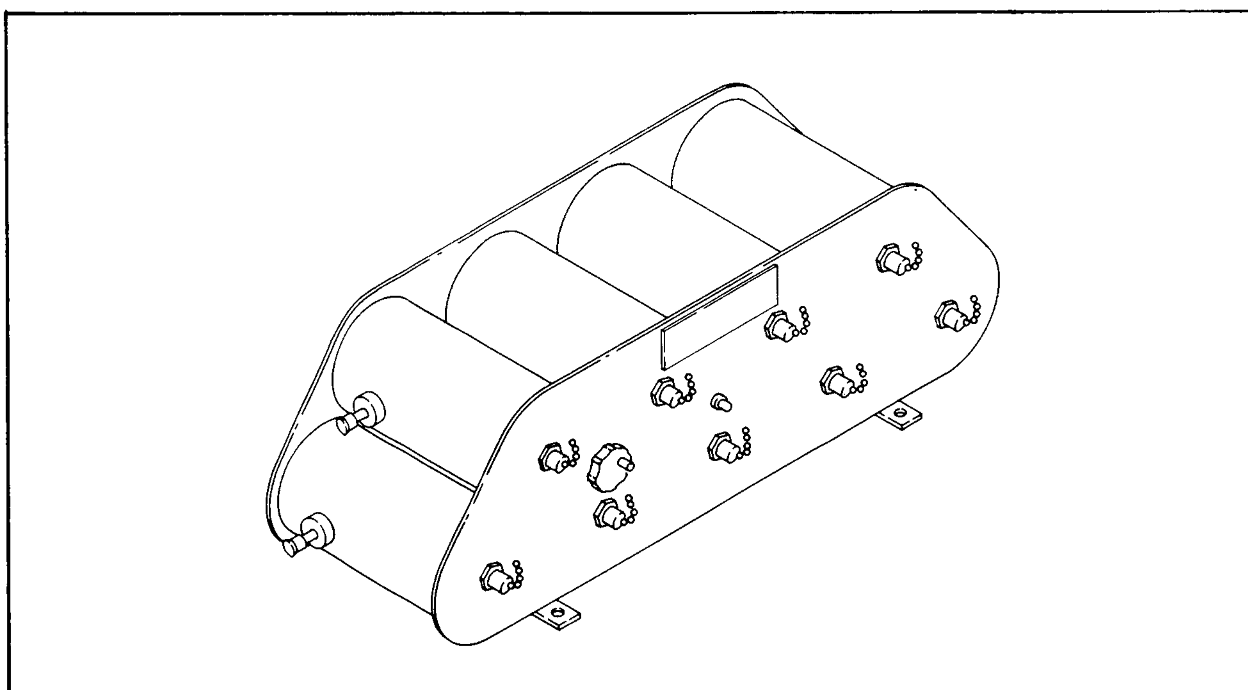


Figure 1-7. Active Acquisition Aid Triplexer (Multiplexer)

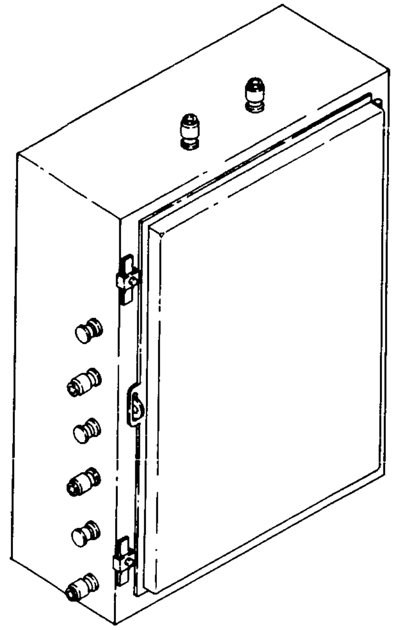


Figure 1-8. Active Acquisition Aid RF Housing

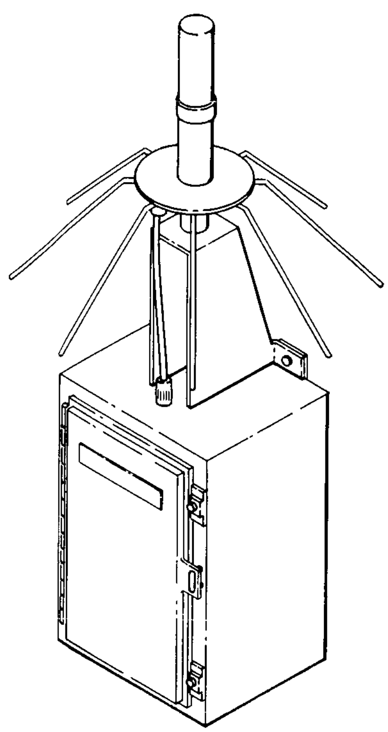


Figure 1-9. Active Acquisition Aid Boresight Antenna and Transmitter

(3). ANTENNA DRIVE POWER CUTOFF SWITCH AND WARNING LIGHT

The antenna drive power cutoff switch and warning light (figure 1-10) contains a double-pole, single-throw switch and a red warning light mounted on a 6-inch by 12-3/4-inch frame.

C. FUNCTIONAL DESCRIPTION

(1). GENERAL

The function of the acquisition system on the Atlantic and Indian Ocean Ships is to acquire and track the capsule and supply tracking information to the transmitting and receiving antenna. Figure 1-11 is a simplified block diagram of the system. The acquisition bus, illustrated by a heavy line, connects two channels (azimuth

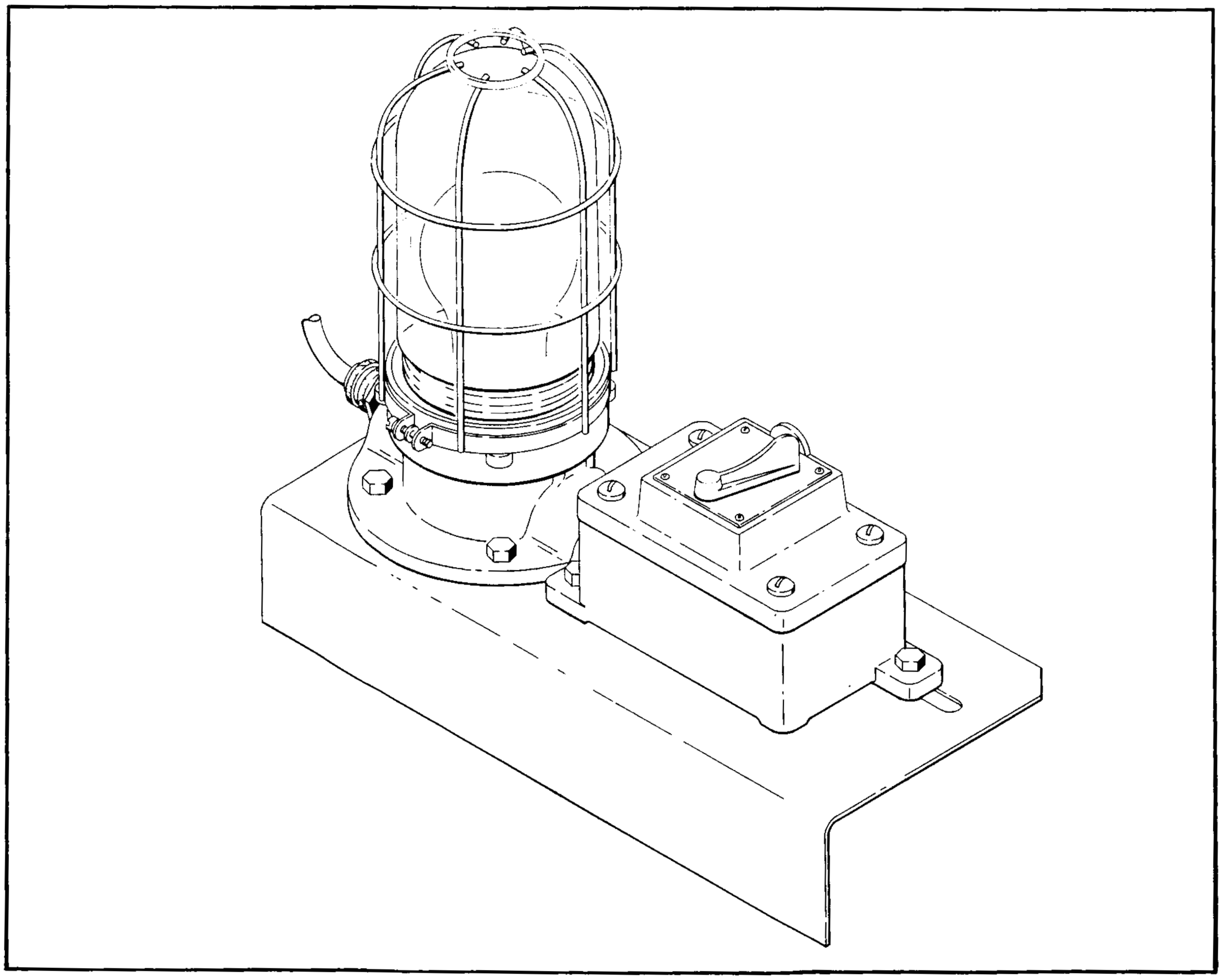


Figure 1-10. Antenna Drive Power Cutoff Switch and Warning Light

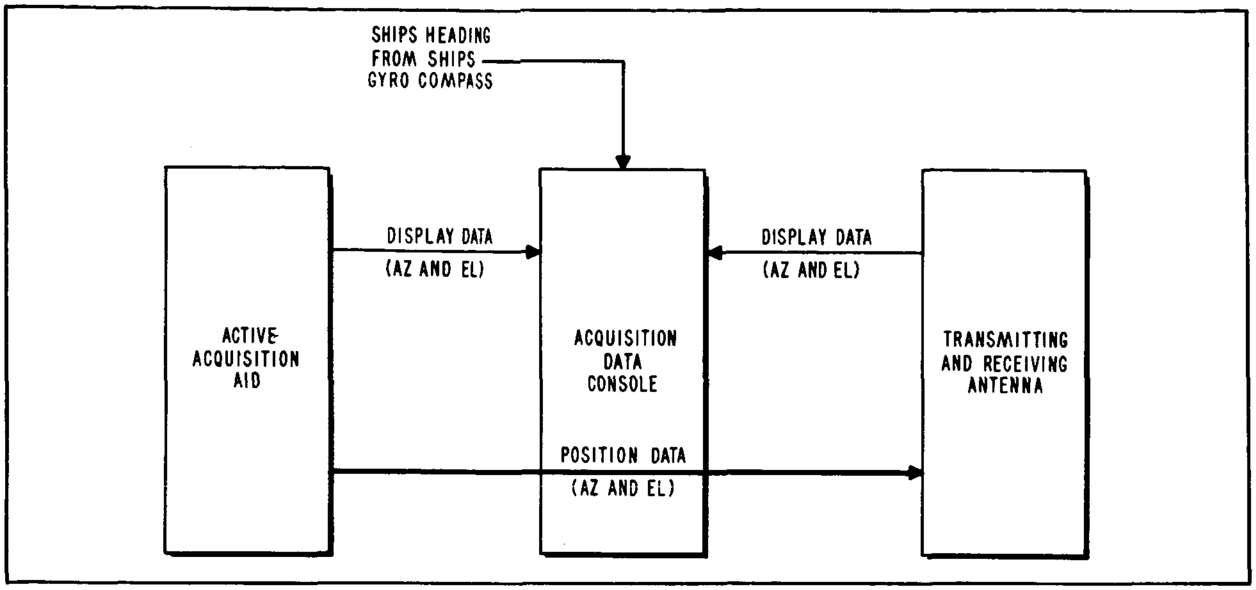


Figure 1-11. Acquisition System, Simplified Block Diagram

and elevation) of position data from the active acquisition aid to the transmitting and receiving antenna. The transmitting and receiving antenna is normally slaved to this data at all times during a capsule pass. Azimuth and elevation display data from the active acquisition aid and the transmitting and receiving antenna is supplied to the acquisition data console where it is used for monitoring the position of the antennas. Ship's heading data in synchro form is supplied to the acquisition data console for use in producing the antenna true azimuth displays. Operating mode and cable wrap information from the two antennas and signal strength indications from the site telemetry receivers also are supplied to the acquisition data console. Audio from the site telemetry receivers is supplied to the active acquisition aid control console. These latter circuits are not shown on figure 1-11.

(2). ACQUISITION DATA CONSOLE

The acquisition data console contains indicator lights, synchro displays (receivers and differential receivers), switches, and signal strength meters. The inputs to the console, other than primary power, are operating mode information in d-c form, cable wrap indications, synchro display data, and signal strength indications. The functions of the various indicators, displays and controls on the console are described in the following paragraphs; a simplified schematic is shown on figure 1-12.

(a). The d-c indications coming into the console from the transmitting and receiving antenna are "SLAVED" and "MANUAL" mode indications and a "CABLE WRAP" indication. The synchro data from the transmitting and receiving antenna is azimuth and elevation display data. This data is displayed by two synchro receivers and one synchro differential receiver on the console. The receivers display elevation and relative azimuth, and the differential display true azimuth. The mode indicators (which are controlled by an operator of the transmitting and receiving antenna servo rack) and the synchro displays allow the acquisition data console operator to monitor the operation of the transmitting and receiving antenna insofar as its positioning in azimuth and elevation is concerned. The cable wrap indications permit the acquisition data console operator to determine the azimuth position of the antenna relative to its cable wrap limits. (The rotation of the transmitting and receiving antenna is restricted to 540 degrees because of cabling which wraps around the pedestal as it turns.)

(b). Ship's heading data from the ship's gyro compass system comes into the acquisition data console to the two differential receivers, where it is added to the relative azimuth display data from the two antennas to produce the true azimuth displays.

(c). The only d-c indication from the active acquisition aid is cable wrap. It is the same as the corresponding indication from the transmitting and receiving antenna. Synchro display data from the active acquisition aid comes into the console and is used in the same way as the display data from the transmitting and receiving antenna; elevation data is displayed by a synchro receiver, and azimuth data is displayed by both a synchro receiver (relative azimuth) and a differential receiver. As noted above, ship's heading data also is supplied to the differential; thus, the differential displays the true azimuth of the antenna. Position data from the active acquisition aid is connected straight through the acquisition data console to the transmitting and receiving antenna.

(d). The signal strength meters on the acquisition data console (not shown on figure 1-12) show the strength of the signal being received by

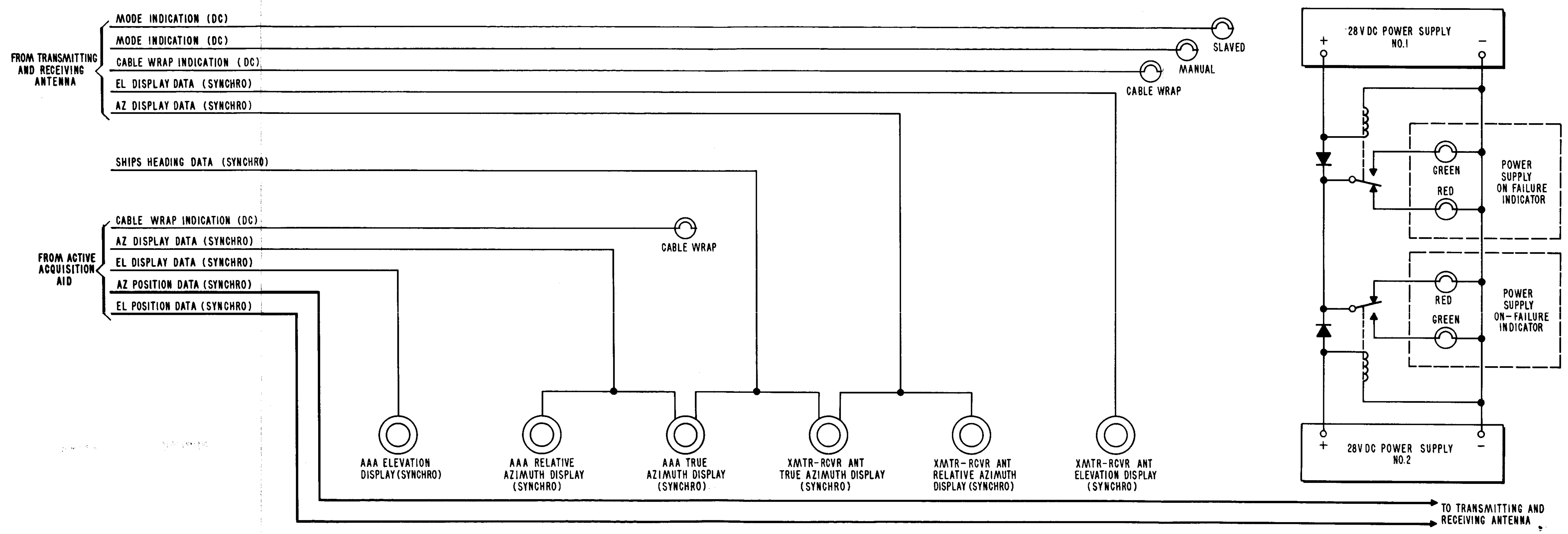


Figure 1-12. Acquisition Data Console, Simplified Schematic Diagram

the four telemetry receivers on the site. Two of the receivers use the active acquisition aid antenna, and the other two use the transmitting and receiving antenna. In an emergency, the antennas can be pointed at the capsule by manual positioning for maximum strength of the received telemetry signals.

(e). There are two 28 VDC power supplies on the acquisition data console, either one of which is capable of supplying all of the power needed to operate the console indicators and controls. Two power supplies are used to increase the reliability of the equipment, and provision is made to disconnect a power supply automatically when its voltage output drops below a certain level. The circuitry which performs this action is shown in simplified form on figure 1-12. Across the output of each of the power supplies there is a control relay whose contacts apply 28 VDC to either a red or a green lamp in the "power supply on-failure indicator." When both power supplies are on and functioning properly, both of the control relays are energized and the green lamps are lit in both indicators. Then, if the voltage output of one power supply drops below a certain value, the control relay associated with that power supply is de-energized and the red lamp in the indicator for that power supply is lit. De-energizing the control relay also causes primary power to be removed from the malfunctioning power supply. (The red indicator lamp is supplied with power from the other, normally-operating power supply.) Note that when one power supply has been turned on and the other has not, a failed indication (red light) is given for the power supply not turned on; the control circuit gives the same indication for a condition of one power supply turned on and one off as it does for both turned on and one malfunctioning.

(3). ACTIVE ACQUISITION AID

(a). The active acquisition aid is an automatic angle-tracking device which provides data to the acquisition system for use by the transmitting and receiving antenna. It tracks the capsule in azimuth and elevation (but not in range) by means of the telemetry signals transmitted from the capsule and puts out azimuth and elevation position and display synchro data. It is also used for telemetry and HF and UHF voice communications reception; refer to the applicable system manuals, MS-102 and MS-106.

(b). The salient characteristics of the active acquisition aid are as follows:

Operating modes: automatic, slaved (not used), manual

Operating frequency: either one of any two, preset frequencies in the range 225 to 260 mc

Tracking accuracy (at 10° per second tracking rate):

Azimuth: 0.5°

Elevation: 0.5° at angles greater than 15°,
1.0° at angles between 10° and 15°

Antenna:

Type of array: quad helix

Polarization: circular, right-hand sense

Elevation limits: minus 10° to plus 110°

Azimuth limit: 540°

Beamwidth: 20° at 3 db points

(c). For a complete functional description of the active acquisition aid, refer to the applicable equipment manual.

(4). ANTENNA DRIVE POWER CUTOFF SWITCH AND WARNING LIGHT

The antenna drive power cutoff switch and warning light is mounted on one of the ladders leading to the active acquisition aid antenna platform. When open, it disconnects antenna drive motor power. The warning light is lit whenever the switch is closed.

1-4. SITE IMPLEMENTATION

A. GENERAL

(1). The following paragraphs deal with the allocation, location, and housing of equipment in the acquisition system on the Atlantic and Indian Ocean Ships. Except as otherwise noted, the information in these paragraphs is applicable to both ships.

(2). The nomenclature used in this manual for the antennas which are part of or connected to the acquisition system differs slightly from the nomenclature used in the capsule communications system manual. For cross reference purposes the two sets of nomenclature are listed below:

ACQUISITION SYSTEM NOMENCLATURE	CAPSULE COMMUNICATIONS SYSTEM NOMENCLATURE
Active Acquisition Aid Antenna	Receiving Antenna
Transmitting and Receiving Antenna	Voice Receiving and Transmitting Antenna

B. SITE DESCRIPTION

(1). SITE LAYOUT

The major components of the acquisition system equipment on the ship sites (see figure 1-13) are in the receiver and telemetry room (No. 3 hold), the transmitter equipment area, and on an antenna platform on the main mast.

(2). EQUIPMENT LOCATION

(a). ACQUISITION DATA CONSOLE

The acquisition data console is in the receiver and telemetry room (No. 3 hold) in the location shown in figure 1-14.

(b). ACTIVE ACQUISITION AID

The active acquisition aid control console and receiver and servo cabinets are in the receiver and telemetry room next to the acquisition

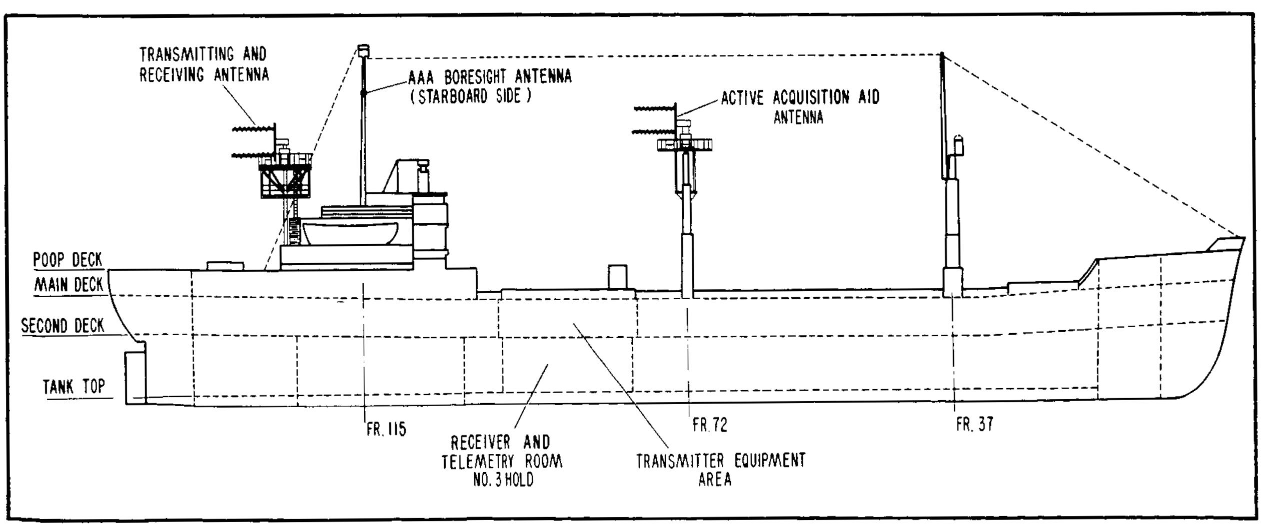


Figure 1-13. Atlantic and Indian Ocean Ships

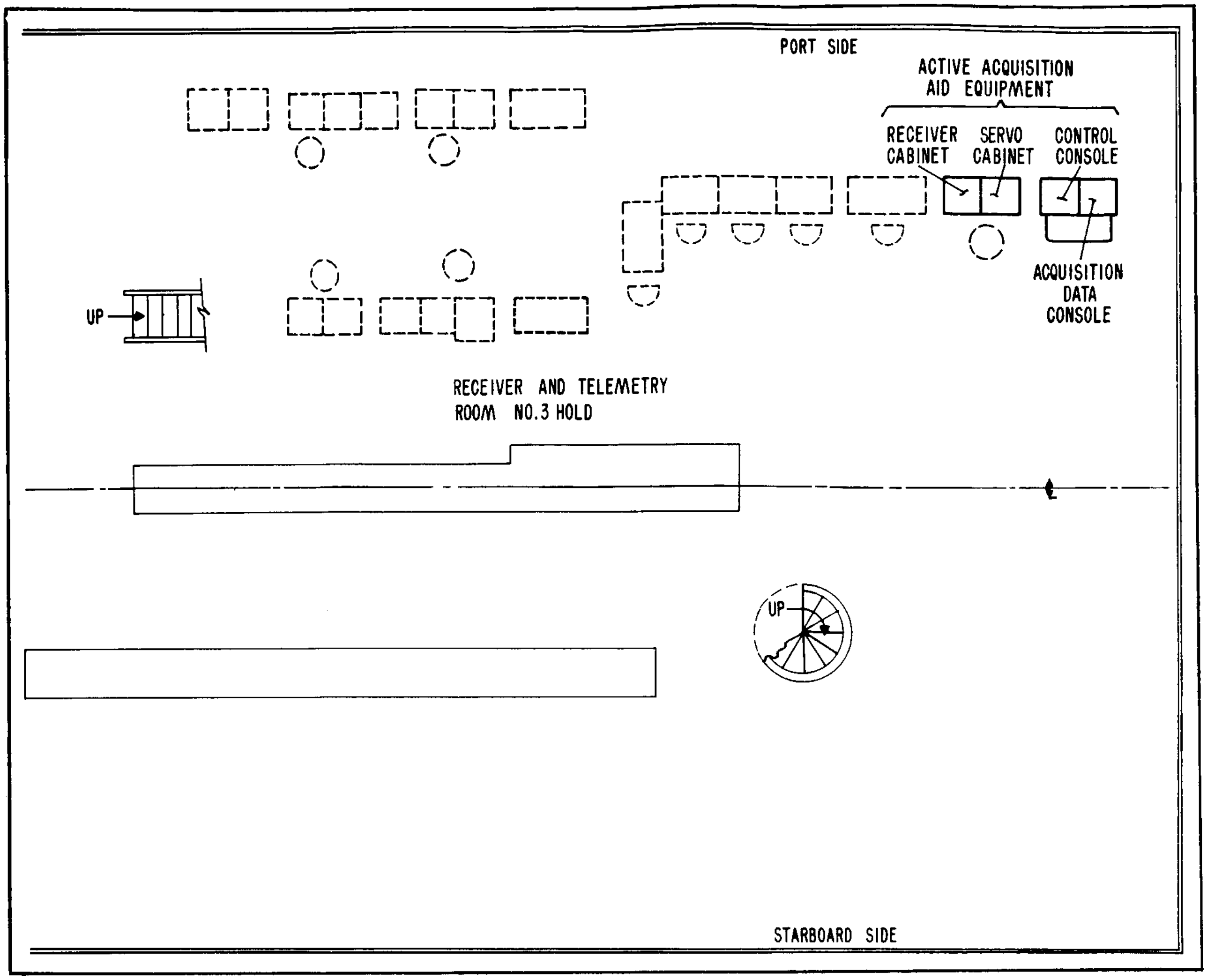


Figure 1-14. Equipment Layout, Receiver and Telemetry Room No. 3 Hold

data console as shown in figure 1-14. The amplidynes are in the transmitter equipment area, figure 1-15. The active acquisition aid antenna is on a platform on the ship's mainmast (see figure 1-13). The RF housing, triplexer and diplexers are underneath the antenna platform. The antenna drive power cutoff switch and warning light assembly is on one of the ladders leading to the antenna platform. (For the exact location of the equipment on or near the antenna platform, refer to the illustrations in Section II.) The active acquisition aid boresight antenna is in the location shown on figure 1-13. On the Atlantic Ship the boresight transmitter is mounted on top of the active acquisition aid control console.

On the Indian Ocean Ship it is mounted in the lower part of the acquisition data console.

(c). <u>TRANSMITTING AND RECEIVING ANTENNA</u>

The transmitting and receiving antenna is not part of the acquisition system, but is connected to it. The antenna is on a platform on the kingpost (figure 1-13). The antenna servo rack is in the transmitter equipment area (figure 1-15).

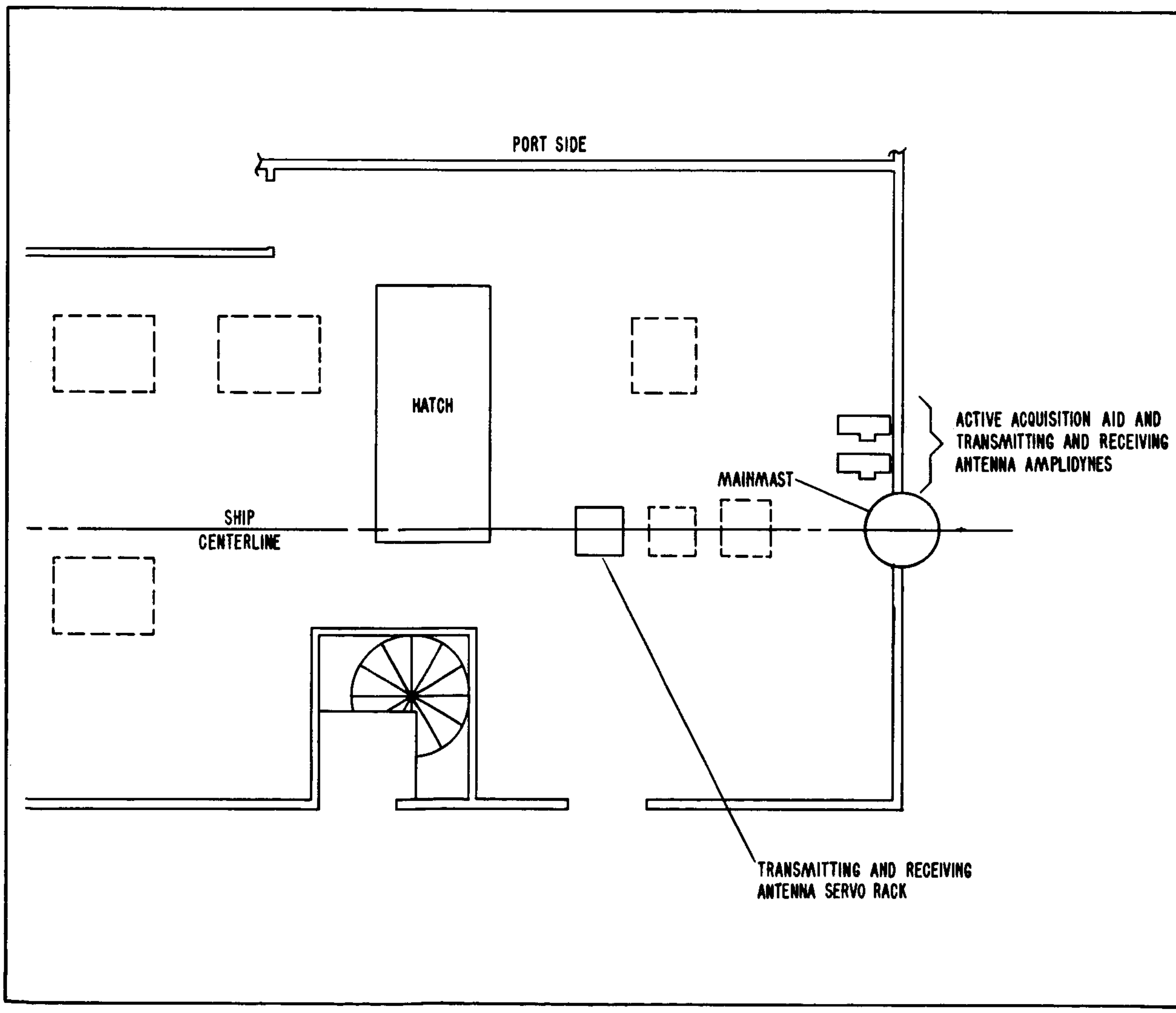


Figure 1-15. Equipment Layout, Transmitter Equipment Area

SECTION II
INSTALLATION

2-1. GENERAL

This section comprises instructions and other information for installing the equipment which makes up the acquisition system.

2-2. EQUIPMENT INSTALLATION

A. CONSOLES AND CABINETS

The consoles and equipment cabinets in the acquisition system comprise two units. One of these consists of the acquisition data console and the active acquisition aid control console. These two consoles are bolted together and are installed as a single unit. The other unit is made up of the active acquisition aid receiver and servo cabinets which, like the consoles, are bolted together and installed as a single unit. Figure 1-14 shows the approximate location of the consoles and cabinets in the receiver and telemetry room. Figure 2-1 gives the outline dimensions of the units, and figure 2-2 shows the mounting hole locations.

B. AMPLIDYNES

The active acquisition aid amplidynes are mounted on a rack constructed for that purpose in the transmitter equipment area. See figure 1-15.

C. ANTENNA AND PEDESTAL

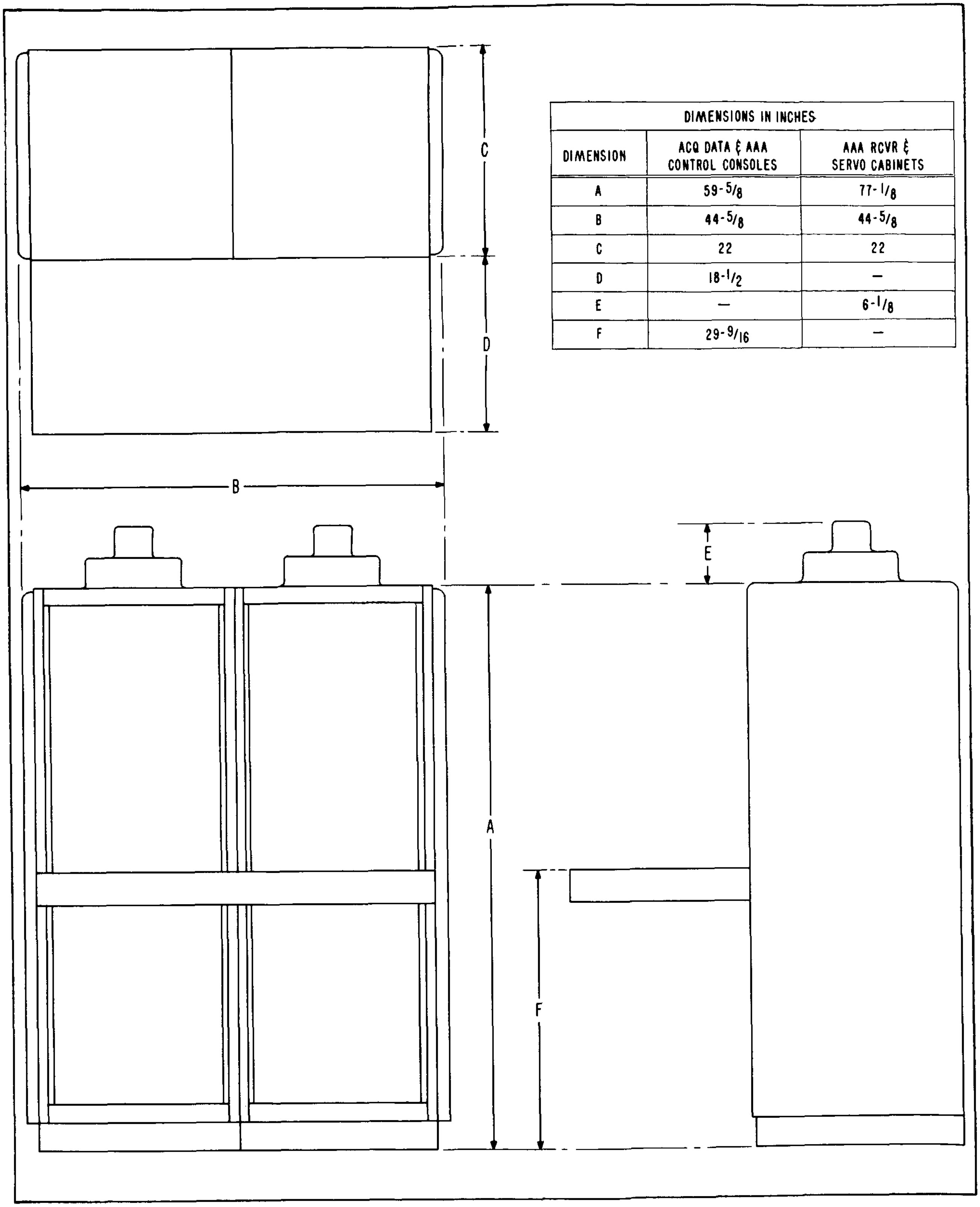
The active acquisition aid antenna and pedestal are installed on a platform on the mainmast, as shown in figure 1-13. For instructions on the installation of the antenna and pedestal, refer to the applicable equipment manual.

D. RF HOUSING AND MULTIPLEXERS

The active acquisition aid RF housing and multiplexers (triplexer and two diplexers) are mounted underneath the mainmast antenna platform. Figure 2-3 shows the locations of these components.

E. UHF VOICE PREAMPLIFIER

The UHF voice preamplifier, which is part of the capsule communications system equipment, is installed along with the active acquisition aid equipment underneath the mainmast antenna platform. See figure 2-3.



DIMENSIONS IN INCHES		
DIMENSION	ACQ DATA & AAA CONTROL CONSOLES	AAA RCVR & SERVO CABINETS
A	59-5/8	77-1/8
B	44-5/8	44-5/8
C	22	22
D	18-1/2	—
E	—	6-1/8
F	29-9/16	—

Figure 2-1. Cabinet and Console Outline Dimensions

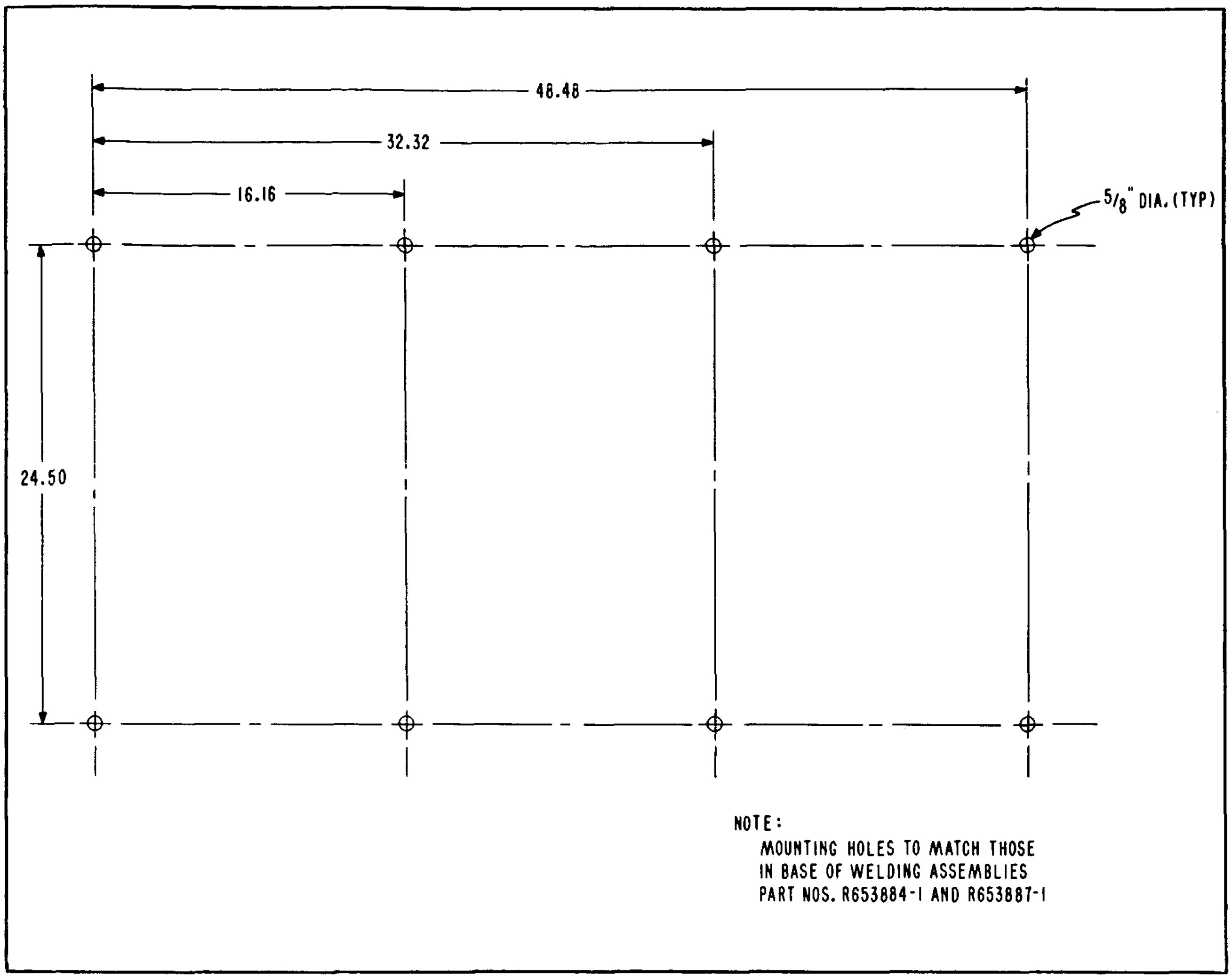


Figure 2-2. Console and Cabinet Mounting Hole Locations

F. ANTENNA DRIVE POWER CUTOFF SWITCH AND WARNING LIGHT

The antenna drive power cutoff switch and warning light is mounted several rungs down from the mainmast antenna platform on the after of the two ladders leading to the platform, as shown in figure 2-3.

G. BORESIGHT TRANSMITTER

The active acquisition aid boresight transmitter locations are described in paragraph 1-4. B. (2).

H. BORESIGHT ANTENNA

The boresight antenna for the active acquisition aid is mounted in the location shown on figure 1-13.

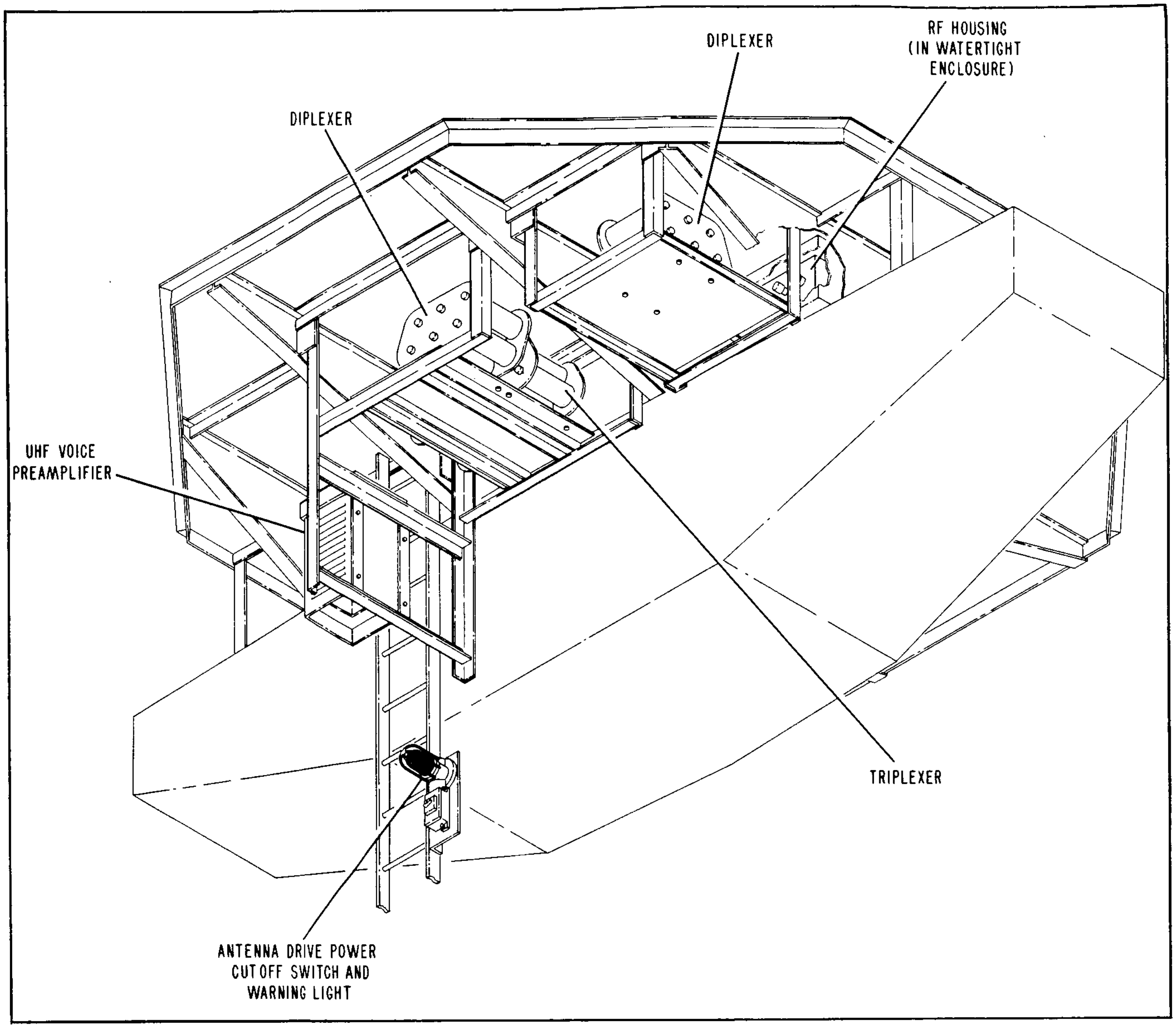


Figure 2-3. Active Acquisition Aid RF Equipment Installation

2-3. INTERCONNECTING CABLING

A. ELECTRICAL INTERCONNECTIONS

An acquisition system interconnecting cabling diagram is included in Section VII (figure 7-12). This diagram shows all of the interconnections within the acquisition system and the interconnections between the acquisition system and equipment of other systems to which the acquisition system is connected. Detailed interconnecting wiring information is not included in this manual. It is provided in separate books, as

"Installation Wiring Information" charts. The part numbers of the charts are L683173-7 (Atlantic Ship) and L683173-11 (Indian Ocean Ship).

B. CABLE INSTALLATION

The physical installation of equipment interconnecting cabling is not covered in this manual. Information on physical installation of interconnecting cabling is included in the installation wiring information charts (refer to the previous paragraph) and is provided directly to the site on separate drawings.

2-4. PRE-OPERATIONAL CHECKS

A. COMPONENT (UNIT) CHECKS

Pre-operational checks of the components of the acquisition system other than the acquisition data console are given in the individual equipment manuals. Pre-operational checks for the acquisition data console are described in Section III of this manual.

B. SYSTEM CHECKS

No pre-operational checks are required for the overall acquisition system. Operational system checks are described in Section III. It should be kept in mind that any malfunctions involving synchros which occur the first time the system checks are run are likely to be caused by incorrect interconnecting wiring of the synchro circuits. Refer to Section V and particularly to figure 5-1 for information on trouble shooting synchro circuit malfunctions.

SECTION III
SYSTEM OPERATION

3-1. GENERAL

A. This section contains a tabulation (table 3-I) and illustrations of the controls on the acquisition data console, initial and normal turn-on procedures for system equipment, system operational checks, and normal and emergency system operating procedures. Complete, detailed procedures are included only for the acquisition data console, since detailed procedures for other system equipment are in the various equipment manuals (listed in table 1-II).

B. For proper operation of the acquisition system, it is necessary that all operators involved have a thorough knowledge and understanding of the makeup, capabilities and limitations of the overall system and the equipment connected to it. Refer to Sections I and IV of this manual.

3-2. INITIAL TURN-ON PROCEDURE

The procedure described in this paragraph is to be followed the first time the equipment is turned on after installation or major repair. For initial turn-on procedures for equipment other than the acquisition data console, see the applicable equipment manuals. The initial turn-on procedure for the acquisition data console is as follows:

A. EXTERNAL POWER CONNECTIONS

(1). With the acquisition data console circuit breaker on the site power panel off, remove all wires except the external power leads from console terminal board TB6001, terminals 1 and 2.

(2). Turn the circuit breaker on and check to see that 115 VAC is applied to console terminals TB6001-1 and TB6001-2. TB6001-1 should be connected to the "hot" wire, and TB6001-2 to the neutral wire. Measure from the terminals to console ground to ascertain which terminal is "hot." (There should be 115 VAC between TB6001-1 and console ground, and no or little voltage between TB6001-2 and console ground.)

(3). Turn the circuit breaker off and reconnect all console wiring terminals TB6001-1 and TB6001-2.

TABLE 3-I. OPERATING CONTROLS, INDICATORS AND DISPLAYS

Name	Function
ACQUISITION DATA PANEL (See Figure 3-1)	
XMTR-RCVR ANT FREQ A TLM RCVR "SIGNAL STRENGTH" METER	Indicates strength of signal at frequency A telemetry receiver connected to transmitting and receiving antenna.
ACTIVE ACQUISITION AID ANTENNA FREQ A TLM RCVR "SIGNAL STRENGTH" METER	Indicates strength of signal at frequency A telemetry receiver connected to active acquisition aid antenna.
XMTR-RCVR ANT FREQ B TLM RCVR "SIGNAL STRENGTH" METER	Indicates strength of signal at frequency B telemetry receiver connected to transmitting and receiving antenna.
ACTIVE ACQUISITION AID ANTENNA FREQ B TLM RCVR "SIGNAL STRENGTH" METER	Indicates strength of signal at frequency B telemetry receiver connected to active acquisition aid antenna.
CALIBRATION CONTROLS	Permit calibration of the signal strength meters to indicate actual strength.
PILOT LAMPS	Correlate audio signal source with signal strength indication.
ACTIVE ACQUISITION AID "TRUE AZIMUTH" DISPLAY	Shows the true azimuth angle (relative to north) of the active acquisition aid antenna.
XMTR-RCVR ANT "TRUE AZIMUTH" DISPLAY	Shows the true azimuth angle (relative to north) of the transmitting and receiving antenna.
ACTIVE ACQUISITION AID "RELATIVE ELEVATION" DISPLAY	Shows the elevation angle of the active acquisition aid antenna relative to the ship.
XMTR-RCVR ANT "RELATIVE ELEVATION" DISPLAY	Shows the elevation angle of transmitting and receiving antenna relative to the ship.
ACTIVE ACQUISITION AID "RELATIVE AZIMUTH" DISPLAY	Shows the azimuth angle of the active acquisition aid antenna relative to the ship's heading.
XMTR RCVR ANT "RELATIVE AZIMUTH" DISPLAY	Shows the azimuth angle of the transmitting and receiving antenna relative to the ship's heading.
"28V SUPPLY" NO. 1 SWITCH AND ON-FAILURE INDICATOR	Turns on power supply No. 1 and indicates whether it is operating properly.
"28V SUPPLY" NO. 2 SWITCH AND ON-FAILURE INDICATOR	Turns on power supply No. 2 and indicates whether it is operating properly.
ACTIVE ACQUISITION AID "CABLE WRAP" INDICATORS	Indicate whether the active acquisition aid antenna is clockwise or counterclockwise from the midpoint of its 540° azimuth travel.

TABLE 3-I. OPERATING CONTROLS, INDICATORS AND DISPLAYS (Cont.)

Name	Function
ACQUISITION DATA PANEL (See figure 3-I) (Cont.)	
XMTR-RCVR ANT "CABLE WRAP" INDICATORS	Indicate whether the transmitting and receiving antenna is clockwise or counterclockwise from the midpoint of its 540° azimuth travel.
XMTR-RCVR ANT MODE INDICATORS	Indicate whether the transmitting and receiving antenna is in the slaved or manual mode of operation.
DUAL POWER SUPPLY (See figure 3-2)	
OFF-ON SWITCH	Controls the application of primary power to the dual power supply.
FUSES	Contain primary power line fuses and indicators to show when a fuse is blown.
POWER-ON INDICATOR	Indicates the application of primary power to the dual power supply.
INTERCOM PANEL (See figure 3-3)	
For information on the intercom panel, refer to the Intrasite PBX and Intercom System Manual, MS-109.	
ACTIVE ACQUISITION AID CONTROL CONSOLE METER AND SWITCH PANEL (Note 1) (See figure 3-4)	
"SIGNAL STRENGTH" METER	Indicates strength of signal at active acquisition aid receiver.
PILOT LAMP	Correlates audio signal source with signal strength indication.
"SELECTOR" SWITCH	Selects one of five sources of audio signal for monitoring and applies 28 VDC to pilot lamp adjacent to signal strength meter which is connected to the audio source selected.
"VOLUME" CONTROL	Adjusts volume of audio signal being monitored.

Note 1: For a description of the two error meters on the meter and switch panel and for all other controls, indicators and displays on the active acquisition aid, refer to the active acquisition aid equipment manual.

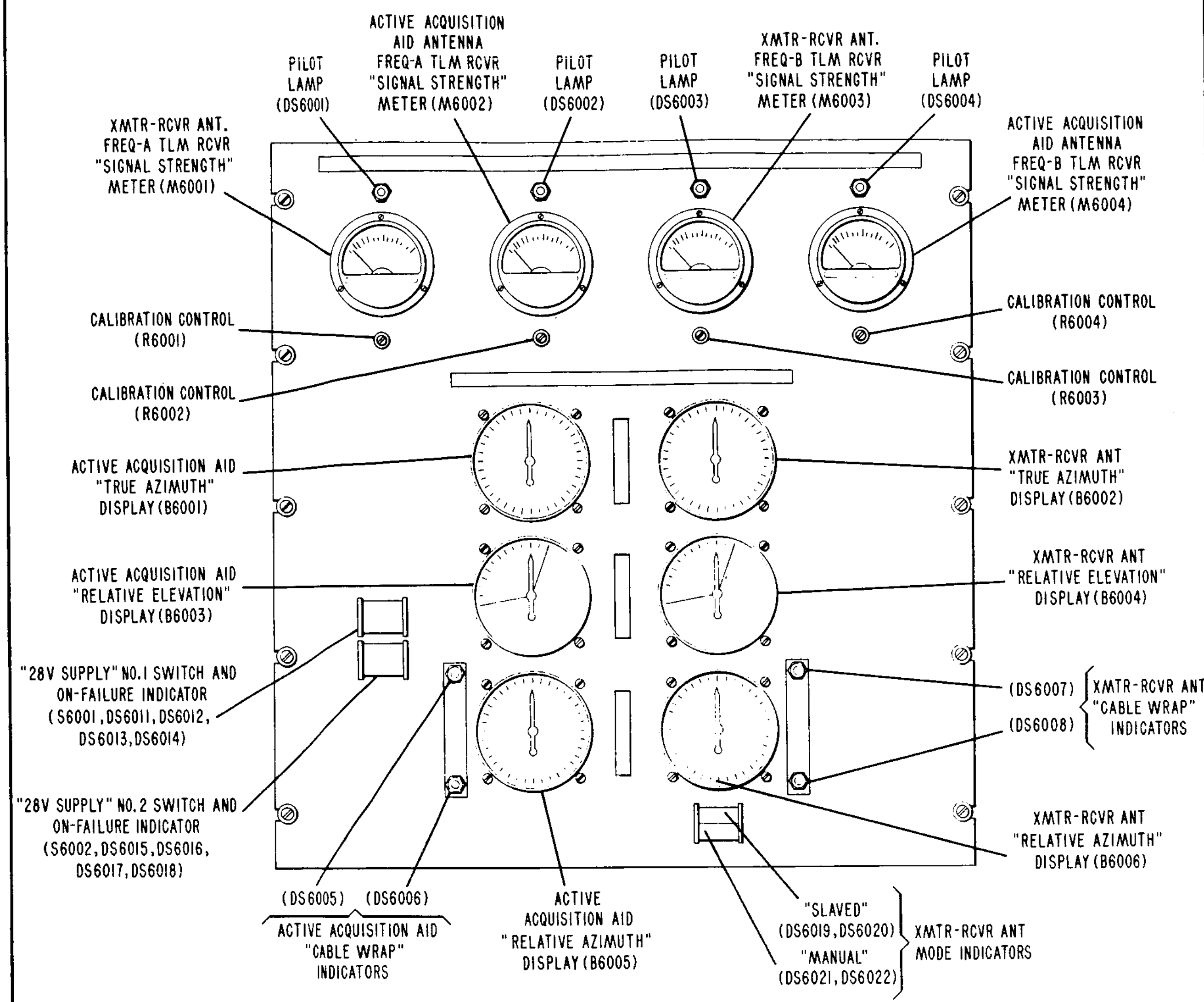


Figure 3-1. Acquisition Data Panel

B. 28 VDC POWER SUPPLY

(1). Turn on the acquisition data console circuit breaker on the site power panel.

(2). Turn on the OFF-ON switch on the dual power supply panel (figure 3-2).

(3). Depress the "28V SUPPLY" number 1 switch on the acquisition data panel (figure 3-1). This action turns on power supply number 1. The on-failure indicator for power supply number 1 should be green and the indicator for power supply number 2 should be red.

(4). Remove the display screens from both of the on-failure indicators. Check to see that all color filters are in place (two red and two green in each indicator). The two lamps in the power supply number 1 indicator with green color filters should be lit, and the two lamps in the power supply number 2 indicator with red color filters should be lit.

(5). Check and, if necessary, adjust the output voltage of power supply number 1 in accordance with the instructions in paragraph 5-4. D. (2).

(6). Turn off power supply number 1 by turning off the OFF-ON switch on the dual power supply panel.

Note

> Because of the long time constant of the power supply filter, several seconds are required after turning off the power supply before the holding coil of the "28V SUPPLY" switch releases.

(7). Turn on the OFF-ON switch on the dual power supply panel.

(8). Depress the "28V SUPPLY" number 2 switch on the acquisition data panel. This action turns on power supply number 2. The on-failure indicator for power supply number 2 should be green and the indicator for power supply number 1 should be red.

(9). Check the indicators of both power supplies to see that both of the lamps with green filters in power supply number 2 indicator are lit and that both of the lamps with the red color filters in the power supply number 1 indicators are lit.

(10). Check and, if necessary, adjust the output voltage of power supply number 2 in accordance with the instructions in paragraph 5-4. D. (2).

(11). Depress the "28V SUPPLY" number 1 switch. The on-failure indicators for both power supplies should be green.

C. INDICATORS

(1). Turn on the acquisition data console circuit breaker on the site power panel.

(2). Turn on the OFF-ON switch on the dual power supply panel (figure 3-2).

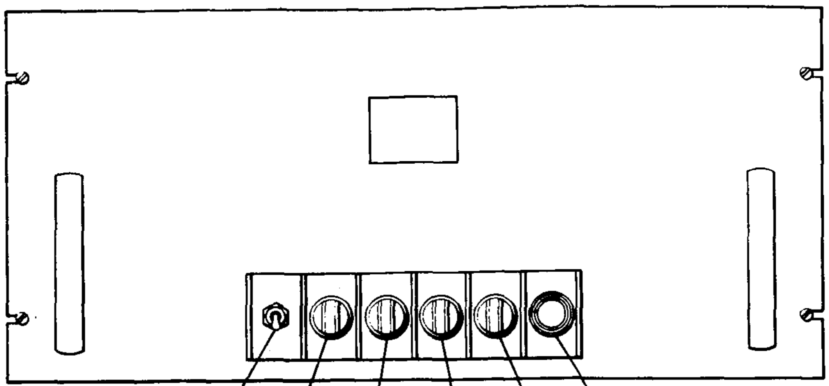


Figure 3-2. Dual Power Supply

(3). Depress the "28V SUPPLY" number 1 and number 2 switches on the acquisition data panel (figure 3-1).

(4). Check the operation of each of the console indicators by completing its circuit with a temporary jumper to a 28 VDC source; e.g., TB6001-3. The indicators to be checked in this manner and the associated terminals to be jumpered to 28 VDC are listed in table 3-II. As each of the indicators is lighted, remove its display screen to see that both color filters are in place and that both lamps are working (except for the cable wrap indicators, which have no color filter and only one lamp).

TABLE 3-II. INDICATOR CHECKOUT PROCEDURE

Indicator	Terminal to be Jumpered
Active Acquisition Aid "CABLE WRAP" (DS6005)	TB6003-1
Active Acquisition Aid "CABLE WRAP" (DS6006)	TB6003-2
Transmitting and Receiving Antenna "CABLE WRAP" (DS6007)	TB6002-5
Transmitting and Receiving Antenna "CABLE WRAP" (DS6008)	TB6002-7
Transmitting and Receiving Antenna "SLAVED" (DS6019, DS6020)	TB6002-1
Transmitting and Receiving Antenna "MANUAL" (DS6021, DS6022)	TB6002-3

D. SIGNAL STRENGTH METERS

As part of the initial turn-on procedure, the meters on the acquisition data console (figure 3-1) require calibration. Refer to paragraph 5-4.G. for detailed instructions.

E. SYNCHROS

There is no convenient means of performing checks on the synchros without operation of the entire acquisition system and all of the equipment connected to it. Therefore, the initial check of these items should be made during the first system operational check (paragraph 3-4).

F. INTERCOM PANEL

For information on the intercom panel, refer to the Intrasite PBX and Intercom System manual, MS-109.

3-3. NORMAL TURN-ON PROCEDURE

A. For normal turn-on procedures for all equipment other than the acquisition data console, see the applicable equipment manuals.

CAUTION

Before applying power to the active acquisition aid, be sure that the transmitting and receiving antenna are in the manual mode of operation.

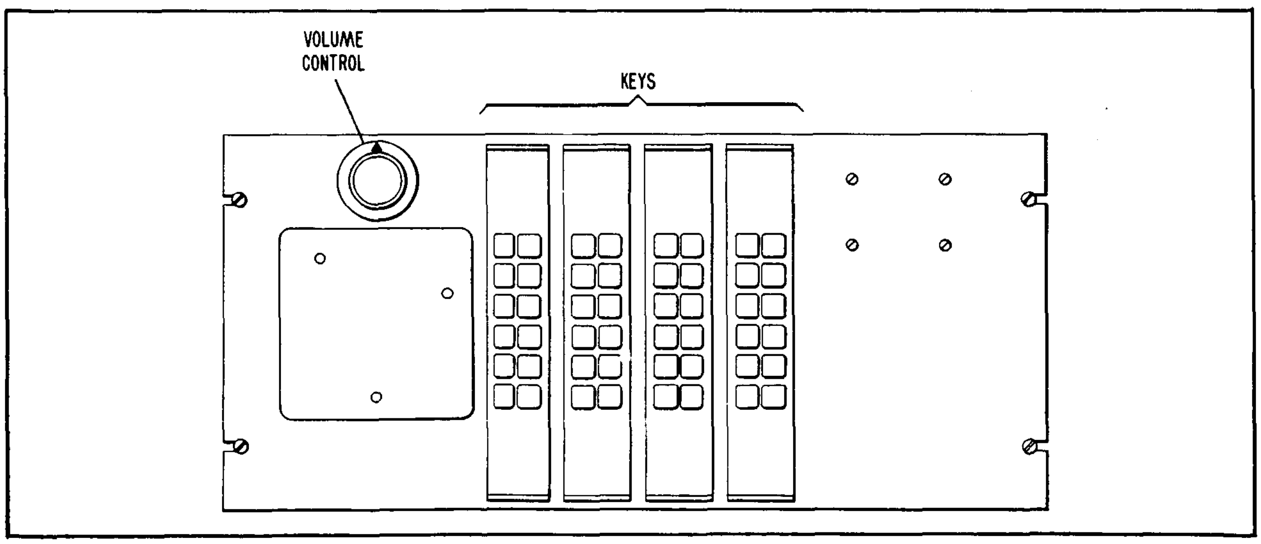


Figure 3-3. Intercom Panel

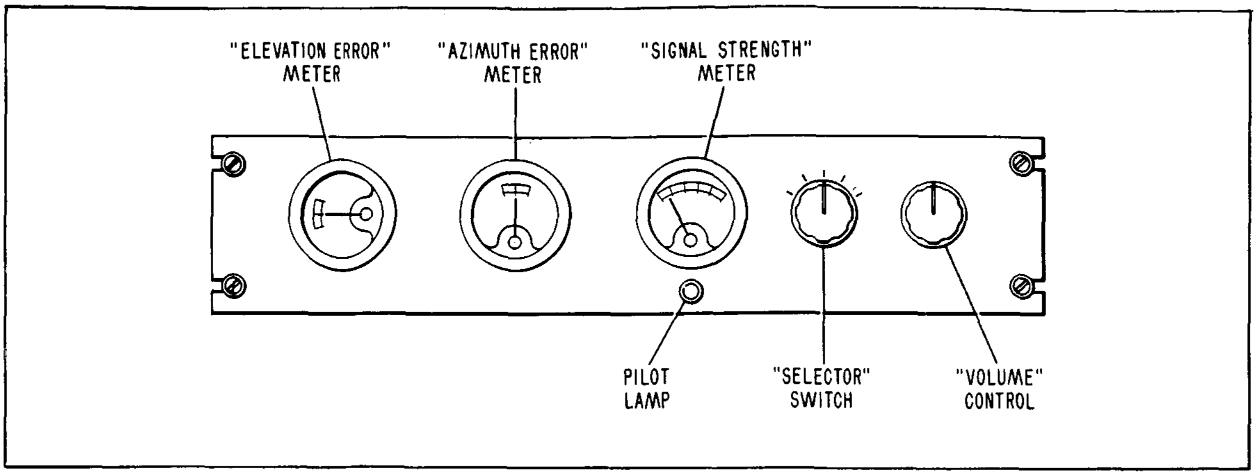


Figure 3-4. Active Acquisition Aid Control Console Meter and Switch Panel

B. For normal turn-on of the acquisition data console, proceed as follows:

(1). Turn on the acquisition data console circuit breaker on the site power panel.

(2). Turn on the OFF-ON switch on the dual power supply (figure 3-2).

(3). Depress the "28V SUPPLY" number 1 and number 2 switches (figure 3-1). Both of the associated indicators should come on and should be green. The acquisition data console is now ready for operation.

3-4. SYSTEM OPERATIONAL CHECKS

This paragraph describes the checks to be performed to ascertain that the acquisition data console and the overall acquisition system are in satisfactory operating condition. Detailed procedures for equipment other than the acquisition data console are given in the applicable individual equipment manuals. All of the checks for each individual piece of equipment and for the overall system are to be performed after initial turn-on of the equipment and again shortly before each Mercury operation.

A. D-C INDICATIONS

(1). Check the console 28 VDC power supply in accordance with the instructions in paragraph 3-2. B.

(2). By intercom, direct the operator of the transmitting and receiving antenna to switch his equipment successively to the manual and slaved modes of operation. The "SLAVED" indication should appear on the acquisition data console when both the azimuth and elevation "LOCAL-REMOTE" switches on the transmitting and receiving antenna servo rack are in the "REMOTE" position. When either one or both is in the "LOCAL" position, a "MANUAL" indication should appear on the acquisition data console.

CAUTION

> If the active acquisition aid is energized when this check is performed, have the transmitting and receiving antenna operator manually set his antenna to the approximate azimuth and elevation of the active acquisition aid before switching to slaved operation. The purpose of this procedure is to avoid sudden, large changes in the inputs to the transmitting and receiving antenna positioning system. Such step-function inputs impose unnecessary wear on the equipment, and under certain circumstances can drive the antenna into its azimuth or elevation limit stops.

(3). Direct the operator of the transmitting and receiving antenna to set the antenna to approximately 260 degrees relative azimuth and then slowly rotate it in the clockwise (increasing azimuth) direction. As the antenna passes 270 degrees, the associated upper (clockwise indicating) cable wrap indicator on the acquisition data console should light. Direct the operator to set the antenna at approximately 280 degrees and then slowly rotate it in the counterclockwise direction. As the antenna passes 270 degrees, the associated lower cable wrap indicator should light.

(4). Set the active acquisition aid antenna to approximately 260 degrees relative azimuth and perform a check of the cable wrap indicators on the acquisition data console as in the previous step.

B. <u>SYNCHROS</u>

(1). With both the active acquisition aid and the transmitting and receiving antenna in the manual mode of operation, set the active acquisisition aid antenna to precisely zero degrees relative azimuth and elevation.

(2). Direct the operator at the transmitting and receiving antenna to turn his antenna to zero degrees relative azimuth and elevation and then switch to the slaved mode of operation (both "LOCAL-REMOTE" switches in the "REMOTE" position).

(3). Have the transmitting and receiving antenna operator check the antenna azimuth and elevation displays on his servo rack. They both should be at zero degrees ±3.0 degrees.

(4). On the acquisition data console check the relative azimuth and elevation displays from the active acquisition aid and the transmitting and receiving antenna. They should agree with the displays on the active acquisition aid control console within ±3.0 degrees.

(5). On the acquisition data console check the true azimuth diaplsy from the active acquisition aid and the transmitting and receiving antenna. They should be within ±3.0 degrees of the sum of the angles of the active acquisition aid antenna's relative azimuth (as displayed on the active acquisition aid control console) and the ship's true heading. Refer to table 3-III for examples of correct true azimuth displays for several combinations of antenna relative azimuth and ship's true heading.

TABLE 3-III. EXAMPLES OF CORRECT TRUE AZIMUTH DISPLAYS

Antenna Relative Azimuth (degrees)	Ship's True Heading (degrees)	Antenna True Azimuth (degrees)
5	10	15
170	30	200
80	300	20
340	290	270

(6). Manually change the active acquisition aid antenna relative azimuth from zero to 360 degrees in 30-degree steps and change the elevation from zero to 90 degrees, also in 30-degree steps. At each step in azimuth and elevation check the antenna position displays on the acquisition data console for agreement with the active acquisition aid control console displays as in the previous two steps.

C. SIGNAL STRENGTH METERS

Check the calibration of the meters on the acquisition data console in accordance with the instructions in paragraph 5-4. G.

3-5. NORMAL OPERATING PROCEDURE

A. PREPARATION FOR CAPSULE PASS

(1). Perform the system operational checks (paragraph 3-4).

(2). Turn on the acquisition data console (paragraph 3-3).

(3). Direct the operator of the transmitting and receiving antenna to turn on his equipment and put it in the manual mode of operation. Check to see that a "MANUAL" indication is received on the acquisition data console.

(4). Turn on the active acquisition aid and put it in the manual mode of operation.

(5). Set the active acquisition aid antenna to the predicted elevation and true azimuth of the capsule's arrival over the horizon.

(6). Have the transmitting and receiving antenna operator set his antenna to the approximate azimuth and elevation of the active acquisition aid and then switch to the slaved mode of operation. Verify the operating mode of the transmitting and receiving antenna by checking the "SLAVED" indication on the acquisition data console.

(7). Check the slaving accuracy of the transmitting and receiving antenna. The relative azimuth and elevation displays on the acquisition data console should agree with those on the active acquisition aid within ±3.0 degrees.

B. INITIAL ACQUISITION

(1). In the Mercury capsule there are two telemetry transmitters which operate at different frequencies in the 225- to 260-megacycle band. The active acquisition aid may be switched to receive either of these frequencies and should be operated on whichever frequency is expected to produce the better results. Criteria to be used in selecting the operating frequency include performance during prior missions and performance during maintenance and tests. Set and keep the active acquisition aid on one frequency during initial acquisition and subsequent tracking unless difficulty is encountered. If difficulty is encountered, switch to the other frequency to see if better results are obtained.

(2). Watch the signal strength meters and panalyzor and listen for telemetry audio. These will be the first indications that the capsule is in range.

(3). As soon as there are indications that a signal is being received, monitor the azimuth and elevation error meters and position the active acquisition aid antenna for zero azimuth and elevation error. Then switch to automatic tracking and closely monitor the action of the active acquisition aid on the control console synchro displays.

(4). At low elevation angles the active acquisition aid may track a reflected signal. Therefore, closely monitor the control console synchro displays, particularly the elevation display. If the indicated elevation angle goes below the known horizon, switch to the manual elevation mode and position the antenna for minimum elevation error signal indication at an elevation above the horizon. Manually track the capsule in elevation until it is a few degrees (five to ten) above the horizon and then switch back to fully automatic tracking (both channels in automatic).

C. TRACKING

(1). After initial acquisition, continue to operate in fully automatic tracking for the duration of the capsule pass. Monitor the transmitting and receiving antenna synchro displays on the acquisition data console to be sure that it properly follows the position of the active acquisition aid. If the active acquisition aid loses the track during the capsule pass, proceed as follows:

(a). Switch to the manual mode of operation.

(b). Set the antenna to the best position (estimated or in accordance with predicted data if available) for re-acquisition.

(c). Search for the capsule (by varying the antenna azimuth and elevation) until a signal is received. Position the antenna for zero azimuth and elevation error signals (on the active acquisition aid error meters) and then switch to automatic tracking.

3-6. EMERGENCY OPERATING PROCEDURE

A. OPERATION WITH SECONDARY DATA SOURCE

The primary tracking data source for the acquisition system is the active acquisition aid in the fully automatic mode of operation. Secondary data sources, in the order of preference, are listed below. If data from the primary source is not available, the best of the secondary sources which is available should be used.

(1). Active acquisition aid in automatic in one channel, manual in the other.

(2). Active acquisition aid manually positioned in both channels in accordance with the error signal indications.

(3). Active acquisition aid manually positioned in accordance with signal strength indications. (Refer to paragraph 4-2. C. (2).)

(4). Either antenna manually positioned in accordance with predicted data.

B. OPERATION WITH COMPONENT MALFUNCTION

In many instances if a component fails and cannot be repaired or replaced in the time available, temporary circuit connections can be made which will allow at least limited operation of the system. It is, of course, impractical to attempt to give specific instructions covering all possible failures; maintenance personnel must have sufficient knowledge of the system to devise temporary fixes on the spot. However, to illustrate the types of fixes that might be used, some examples are given in the following paragraphs.

(1). ACQUISITION DATA CONSOLE 28 VDC POWER SUPPLY

(a). Each of the two 28 VDC power supplies in the acquisition data console is capable of easily supplying all of the current needed in the console and 28-volt devices connected to it. Therefore, failure of one supply reduces the reliability of the console, but does not make it inoperative.

(b). Should both of the console 28-volt supplies fail, 28 VDC can be supplied to the console from other, nearby equipment (preferably the communication technician's console): Turn off the dual power supply OFF-ON switch (figure 3-2) and check the console 28 VDC bus to see that it is not shorted to ground. Jumper any convenient terminal on the console 28 VDC bus (see figure 7-1) to a source in other equipment which can supply about one ampere in addition to its normal load. (The communication technician's console 28 VDC supply easily meets this requirement.) Also connect a jumper between acquisition data console ground and the negative side of the external 28-volt supply. The acquisition data console can now be operated normally except for turning 28 VDC off and on.

(2). SYNCHROS

A defective synchro in a critical place can be replaced by another synchro from a less critical place. For example, if the active acquisition aid true azimuth display differential receiver fails, it can be replaced by the transmitting and receiving antenna true azimuth differential receiver.

SECTION IV
THEORY OF OPERATION

4-1. GENERAL

With the exception of the acquisition data console, which is treated in detail, this section presents the theory of operation of the acquisition system on a block diagram level. Adjoining systems, those which receive information from or supply information to the acquisition system, are treated only to the extent of their interconnections with the acquisition system. For further information on these systems, see the applicable system manuals. For detailed information on the acquisition system components which are described only on a block diagram level, see the applicable equipment manuals. These manuals are listed in table 1-II.

A. FUNCTION OF THE SYSTEM

As was described in Section I, the function of the acquisition system is to acquire and track the capsule and supply information on the capsule's azimuth and elevation to the transmitting and receiving antenna. The active acquisition aid antenna in addition to its tracking function is used for telemetry, HF voice, and UHF voice reception. The transmitting and receiving antenna and its associated equipment cannot track a target automatically. Therefore, it is normally slaved to data from the acquisition system at all times during a capsule pass.

B. NORMAL OPERATION

The following is a description of the normal sequence of events in the acquisition system during a typical pass of the capsule. It should be noted that several variations from the normal sequence are possible. These variations are not discussed in the following description, but should be apparent once the capabilities of the system are understood.

(1). Prior to the pass, predicted target position coordinates — azimuth, elevation, range, and time — are sent to the site in plain text from Goddard Space Flight Center. Coordinates for four or five times along the orbit are sent: time of arrival at 700 nautical miles range, 30 seconds later, 60 seconds later, 90 seconds later, and time for position just past zenith when a zenith pass of the capsule is expected. The first set of coordinates is read over the intercom to the active acquisition aid operator, who manually sets the position of the active acquisition aid antenna accordingly. After the active acquisition aid antenna is set to the correct position, the transmitting and receiving antenna is set to the same position and then slaved to the acquisition bus (i.e., slaved to data from the active acquisition aid). If acquisition (automatic tracking) of the capsule is not accomplished at the time specified by the first set of predicted coordinates, the next three of the remaining sets of coordinates are read and set into the system at the times given. The coordinates just past zenith are used as an aid in re-acquiring the capsule if automatic tracking is lost as it passes overhead.

(2). Once the active acquisition aid has acquired the capsule, it continues automatic tracking until the capsule is out of range, and the transmitting and receiving antenna remains slaved to the acquisition bus for the duration of the pass.

4-2. DETAILED DISCUSSION

A. DISCUSSION OF OVERALL SYSTEM

This paragraph discusses the complete acquisition system on a block diagram level (see figure 4-1). Paragraph 4-2. B. and subsequent paragraphs discuss individual components and subsystems of the acquisition system.

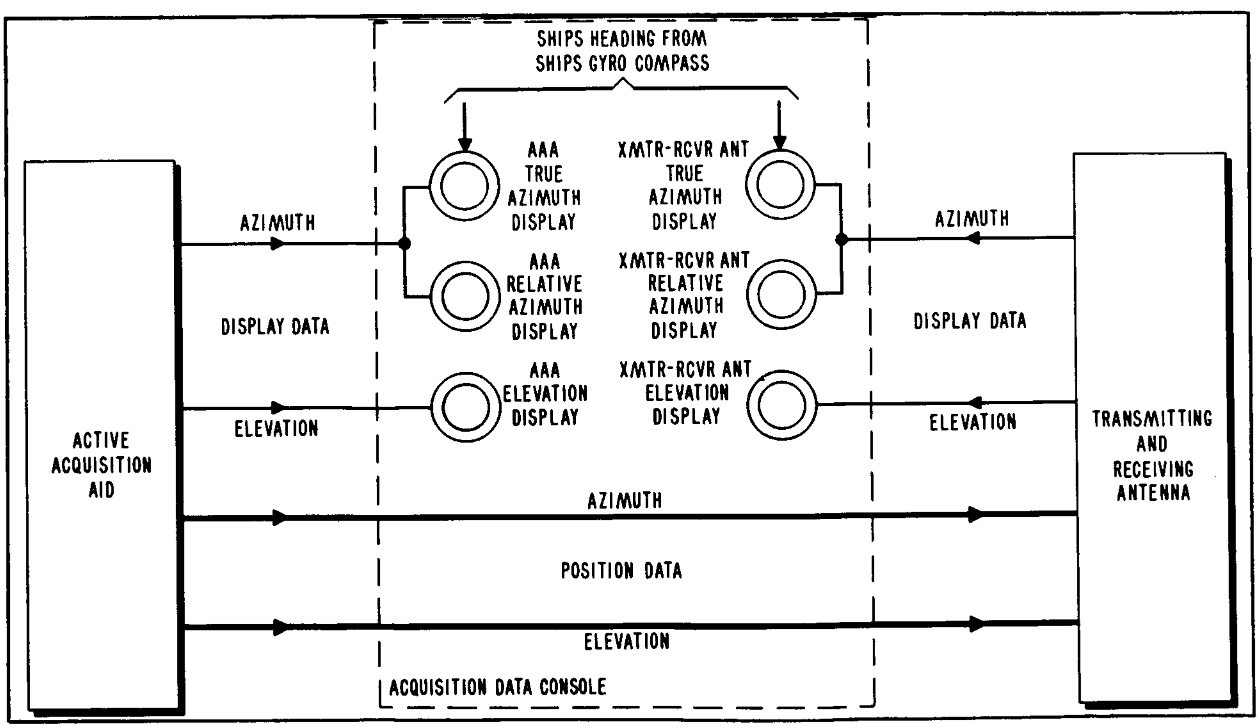


Figure 4-1. Acquisition System, Block Diagram

(1). Azimuth and elevation slaving data originate at synchro transmitters in the active acquisition aid and are connected there to the acquisition bus. (The acquisition bus is indicated by the heavy lines on figure 4-1.) The acquisition bus is connected directly through the acquisition data console to the transmitting and receiving antenna. The transmitting and receiving antenna is normally slaved to the data on the acquisition bus at all times during a capsule pass.

(2). Azimuth and elevation display data comes from two synchro transmitters in the active acquisition aid (these transmitters are separate from the position data transmitters) and is fed to the acquisition data console. The elevation display data is connected directly to the elevation synchro receiver on the console, where it is displayed for monitoring. (This display shows the relative elevation of the active acquisition aid antenna.) Azimuth display data is fed in parallel to the relative azimuth and true azimuth synchro displays. The relative azimuth display shows the azimuth of the antenna relative to the ship's heading. The true azimuth display synchro mixes the active acquisition aid relative azimuth synchro signal with ship's heading synchro signal to produce a display of the true azimuth of the active acquisition aid antenna. The true azimuth display synchro is a differential receiver.

(3). Ship's heading information in synchro form from the ship's gyro compass system is fed into the acquisition data console. It goes to the active acquisition aid and the transmitting and receiving antenna true azimuth displays. Its use is as described in the previous paragraph.

(4). Azimuth and elevation display data from the transmitting and receiving antenna comes into the acquisition data console and is connected to displays in the same manner as the active acquisition aid display data: the elevation data is connected to the transmitting and receiving antenna relative elevation display, and the azimuth data is connected in parallel to the relative azimuth and true azimuth displays.

(5). In the acquisition system, d-c indications of equipment operating mode and cable wrap position come from the active acquisition aid and from the transmitting and receiving antenna to the acquisition data console. (See figure 7-6.) There are four indications from the transmitting and receiving antenna. Of these, two are operating modes and two are cable wrap. The cable wrap indications show which half of its total azimuth travel (540 degrees) the antenna is in, and when used with the relative azimuth synchro display permit the acquisition data console operator to tell where the antenna is relative to its azimuth limits. The operating mode indications show whether the transmitting and receiving antenna is in its slaved or manual mode of operation.

(6). Only two d-c indications come from the active acquisition aid to the acquisition data console. Both of these are cable wrap indications; they have the same function as those from the transmitting and receiving antenna, described in the previous paragraph.

B. ACQUISITION DATA CONSOLE

(1). DUAL POWER SUPPLY

Switches and indicators on the acquisition data console are energized by 28 VDC from the console 28 VDC supply, which physically consists of the relay chassis, two switches on the acquisition data panel, and the dual power supply. The dual power supply consists of four chassis (two power supply units and two filter units) and a front panel. (See figure 7-3.) Primary power, 115 VAC, is applied through jacks J6201 and J6202 to off-on switch S6201. When switch S6201 is closed, primary power is applied through fuses F6201 through F6204 to the primaries of power transformers T6201 and T6202. The fuses are in indicating-type holders; when a fuse blows, a neon bulb in parallel with the fuse is lit. A neon, power-on indicating lamp, DS6201, is across the line going to power supply unit PS6201. Power supply unit PS6201 and filter unit FL6201 make up power supply number 1; it is a conventional d-c power supply with silicon rectifiers in a bridge configuration and with an LC filter. Note that there is a fuse, F6205, on the d-c side of the power supply. This fuse is not in an indicating type holder. Power supply unit PS6202 and filter unit FL6202 make up power supply number 2, a second d-c power supply which is identical to the first. The secondaries of power transformers T6201 and T6202 have multiple taps to allow adjustment of the output voltage of the power supplies. The voltage difference between taps 1 and 2 is 1.5 VAC and is 3 VAC between taps 3 and 4, 4 and 5, and 5 and 6. Thus by connecting the a-c leads of the rectifier to different taps on the transformer, the a-c input to the rectifier can be varied over a range of 10.5 volts (rms), and the d-c output of the power supply over a range of approximately 14.5 volts.

(2). POWER SUPPLY CONTROL CIRCUITS

The control circuits for the console power supply are shown in figure 4-2. Each of the blocks on figure 4-2 labeled "28 VDC POWER SUPPLY" represents

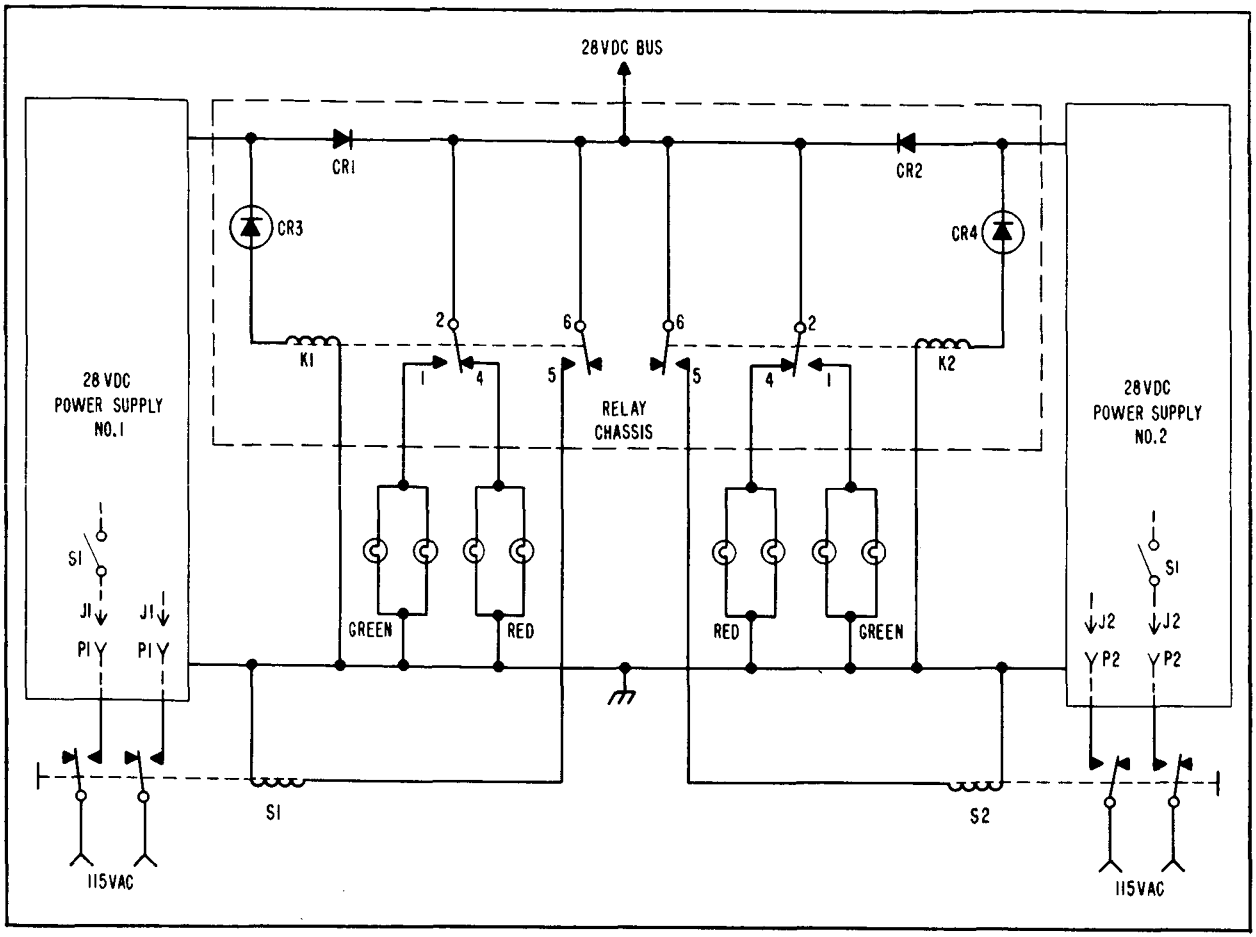


Figure 4-2. Power Supply Control Circuits, Simplified Schematic Diagram

half of the dual power supply discussed in the previous paragraph and shown on figure 7-3. Switches S6001 and S6002 and the indicator lamps are on the acquisition aid panel; the rest of the components of the control circuits are on the relay chassis (mounted on the side of the console, near the acquisition data panel).

(a). When switch S6201 on the dual power supply is closed (see figure 7-3), power is applied to power supply number 1 in the dual power supply through manually operated pushbutton switch S6001. The power supply puts 28 VDC on the bus, and relay K6001 is energized. Power is applied through K6001 contacts 5 and 6 to the coil of switch S6001, thus holding switch S6001 closed and keeping the power supply on. With relay K6001 energized, power is applied through K6001 contacts 1 and 2 to the green indicator lamps, which indicate that the power supply is on and operating properly. If power supply number 2 of the dual power supply has not yet been turned on, power from power supply number 1 through relay K6002 contacts 2 and 4 lights the red indicator lamps associated with power supply number 2, indicating that it is not on. Rectifier CR6002 prevents current from power supply number 1 from circulating through power supply number 2 and from energizing relay K6002 when power supply number 2 is not on.

Note

> The indicator lamps associated with power supply number 1 are in the same physical unit as switch S6001; the lamps associated with power supply number 2 are in the same physical unit as switch S6002.

(b). Zener diode CR6003 in series with the coil of relay K6001 provides a sharp pull-in and drop-out of relay K6001 as the voltage output of power supply number 1 increases or decreases. This action prevents the output of power supply number 1 from being applied to the console 28 VDC bus until it reaches operating value, and in the case of a malfunction resulting in low voltage, disconnects the power supply from the bus. When power supply number 1 is turned on; its voltage output begins to rise. Until the output reaches 18 volts, the resistance of CR6003 is very high, and virtually no current flows through CR6003 and the coil of K6001. As the power supply output increases above 18 volts, the resistance of CR6003 decreases, and rapidly increasing current flows through CR6003 and K6001. (The distinguishing characteristic of zener diodes is that with applied voltages above the diode reference value, 18 volts in this case, and below the maximum rated value, the resistance of the diode varies inversely with the applied voltage. Current through the diode varies greatly, but the voltage drop across it remains practically constant. The action of the diode is thus like that of a VR tube.) When the supply voltage reaches approximately 22.5 volts, sufficient current flows (4.5 milliamperes) to energize relay K6001. Since the resistance of the relay coil is

1000 ohms, the values of voltage and current in the circuit at this point are as follows:

Total applied voltage	22.5 VDC
Voltage drop across CR6003	18 VDC
Voltage drop across K6001 coil	4.5 VDC
Current $\left(\frac{4.5}{1000}\right)$	4.5 MA

As the power supply output continues to increase, the voltage drop across CR6003 remains at approximately 18 volts, the current through the circuit increases to about 10 milliamperes, and the voltage drop across the K6001 coil increases to about 10 volts.

(c). If a malfunction develops such that the output voltage of power supply number 1 begins to drop, relay K6001 will drop out sharply at and output voltage of about 22.5 volts. This action is due to the sharp increase in the resistance of zener diode CR6003 as the voltage across it drops to 18 volts. (As explained in the previous paragraph, with an output from the power supply of 22.5 volts, 4.5 volts appear across the coil of relay K6001, and 18 volts across diode CR6003.) Blocking diode CR6001 prevents current from power supply number 2 from flowing through diode CR6003 and relay K6001. When relay K6001 is de-energized, the holding coil circuit of switch S6001 is opened (by the opening of K6001 contacts 5 and 6), and primary power is disconnected from power supply number 1.

Note

In the preceding and following discussions the values of voltage, current, and resistance given are for purposes of explanation. Actual circuit values vary slightly from those given. For instance, 4.5 milliamperes is the maximum current (per manufacturer's data) which is required for pull-in of relays of the type employed in the control circuit (K6001). The pull-in current for individual relays, however, varies downward from this value. Also, the dropout current of any individual relay is of course less than the pull-in circuit. Hence, relay K6001 may be expected to pull in at a total applied voltage somewhat less than 22.5 VDC and to drop out at a still lower voltage.

(d). The action of the control circuit of power supply number 2 is identical to that of the control circuit of power supply number 1.

(e). A summary of the action of the power supply control circuits is as follows:

1. Switch S6001 is manually closed, and primary power is applied to power supply number 1 (assuming that switch S6201 on the dual power supply has been closed).
2. Power supply number 1 puts 28 VDC on the bus, energizing relay K6001 and lighting the red indicator lamps in the control circuit of power supply number 2.
3. Relay K6001 closes, lighting the green indicator lamps associated with power supply number 1 and applying power to the holding coil of switch S6001.
4. Switch S6001 remains closed, and power supply number 1 is in operation.
5. Switch S6002 is closed and primary power is applied to power supply number 2.
6. Power supply number 2 puts 28 VDC on the bus, in parallel with the power from power supply number 1.
7. Relay K6002 is energized, turning off the red indicator lamps associated with power supply number 2 and lighting the green indicator lamps. Power is applied through K6002 contacts to the holding coil of switch S6002, holding S6002 in the on position. Both power supplies are now in operation.
8. Both power supplies are turned off by opening switch S6201 on the dual power supply.
9. If the voltage output of one of the power supplies drops to approximately 22.5 volts, the control relay (K6001 or K6002) associated with the malfunctioning power supply is de-energized and the primary power to that power supply is removed. Power from the other power supply lights the red indicator lamps of the malfunctioning supply. The ratings of the power supplies

are such that one of them can supply all of the power required by the console in the event of the failure of the other.

(3). SWITCHES AND INDICATORS

(a). A number of switch assemblies and indicator assemblies are used on the acquisition data panel of the acquisition data console. An exploded view of the type of switch assembly used is shown on figure 4-3. The assembly consists of two main, detachable sections; the switch and the operator-indicator unit with coil. The switch has three single-pole, double-throw sections. All of the switch sections are actuated simultaneously by a plunger in the operator-indicator unit. The operator-indicator unit has two main, non-detachable sections: the coil and the indicator. When energized, the coil holds the plunger in its actuated position. The indicator has four lamp sockets, lamps, color filters, and a three-piece display screen. The lamps are white, so the colored lighting of the indicator is obtained by the use of filters which

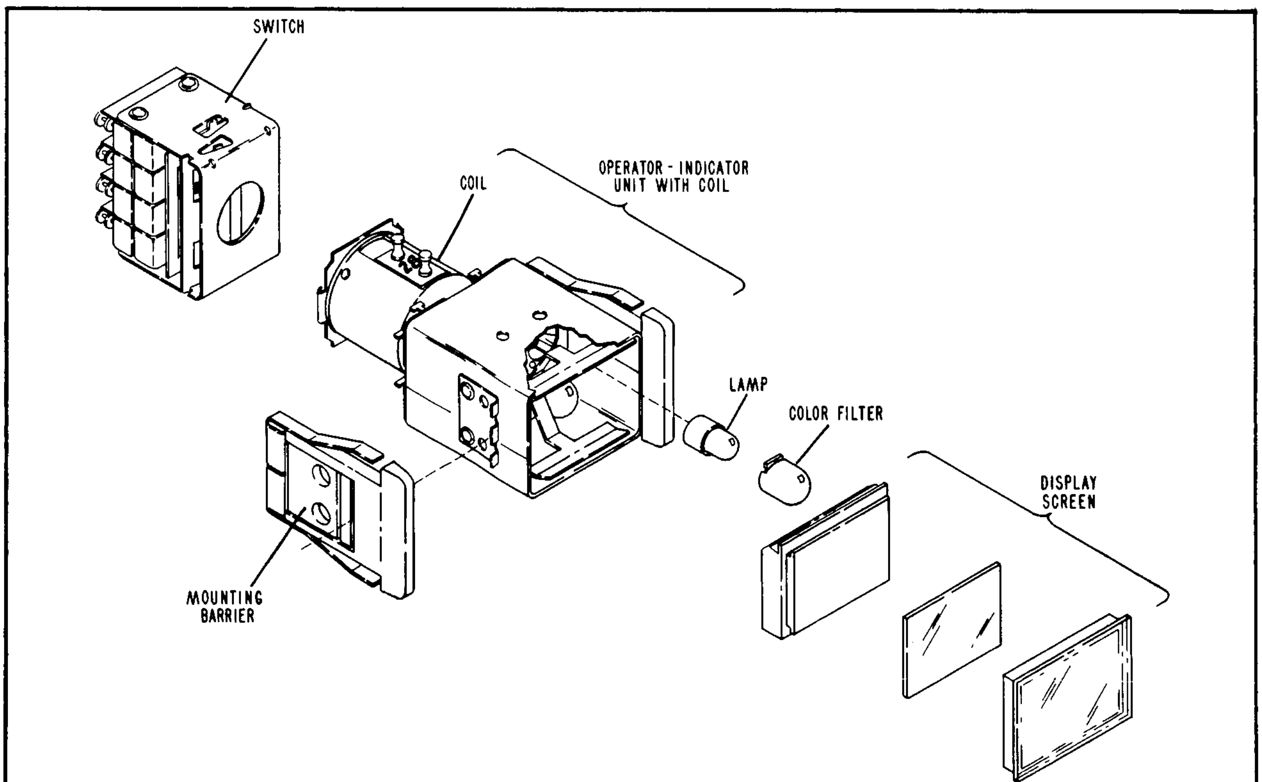


Figure 4-3. Switch Assembly, Exploded View

fit over the lamps. The display screen snaps into the end of the indicator plunger when the indicator is assembled, so that the plunger is moved and the switch actuated by depressing the display screen.

(b). The indicator assemblies used on the console are like the operator-indicator unit shown on figure 4-3, except that the indicator assemblies have no coil and no plunger.

(4). CIRCUIT DESCRIPTION

This paragraph gives a detailed description of the circuits of the acquisition data console except for the power supply, which is described in a previous paragraph.

(a). D-C INDICATIONS

Cable wrap status from the active acquisition aid and cable wrap status and operating mode from the transmitting and receiving antenna are indicated by lamps on the acquisition data console. The lamps are connected to ground in the acquisition data console and are supplied with 28 VDC through switches in the external equipment.

1. The active acquisition aid antenna can rotate 540 degrees in azimuth from its clockwise to its counterclockwise limit. Since it can rotate more than 360 degrees, there are azimuths at which the synchro display alone is ambiguous; i. e., the synchro display shows the azimuth of the antenna, but does not show whether it is on its first or second time around. Since the antenna cannot rotate continuously, it is necessary to know where it is relative to its limits of rotation so that the operator can position it for maximum freedom of rotation in either direction and can avoid driving it into its limit stops. The ambiguity of the synchro display is resolved by the use of "CABLE WRAP" indicator lamps DS6005 and DS6006 which are lit by the closing switch S205 on the antenna pedestal. (See figures 7-1 and 7-6.) This switch is so located that it is actuated when the antenna passes the mid-point between its azimuth limits. The circuit of DS6005 is completed and the circuit of DS6006 is opened when the antenna is rotating clockwise (looking at it from above); the

DS6006 circuits is closed and the DS6005 circuit opened when the antenna is rotating counterclockwise. Note (from figure 7-6) that the cable wrap indicators on the acquisition data console, DS6005 and DS6006, are connected in parallel with those on the active acquisition aid control console, DS1207 and DS1208. At installation the antenna is so oriented that the counterclockwise limit is reached at zero degrees (relative azimuth) and the clockwise limit at 180 degrees. (See figure 4-4.) With this orientation, the cable wrap indicator switching occurs at 270 degrees relative azimuth. Figure 4-5 illustrates how the cable wrap indicator lamps and the antenna azimuth display synchro together show the acquisition data console operator where the antenna is relative to its limits of rotation. When the upper cable wrap indicator is lit (figures 4-5(A) and 4-5 (B)), the antenna has been turned past 270 degrees relative azimuth in a clockwise direction, and if it continues in a clockwise direction the limit of rotation will be reached at 180 degrees relative azimuth. When the lower indicator is lit (figures 4-5(C) and 4-5(D)), the antenna has been turned past 270 degrees in a

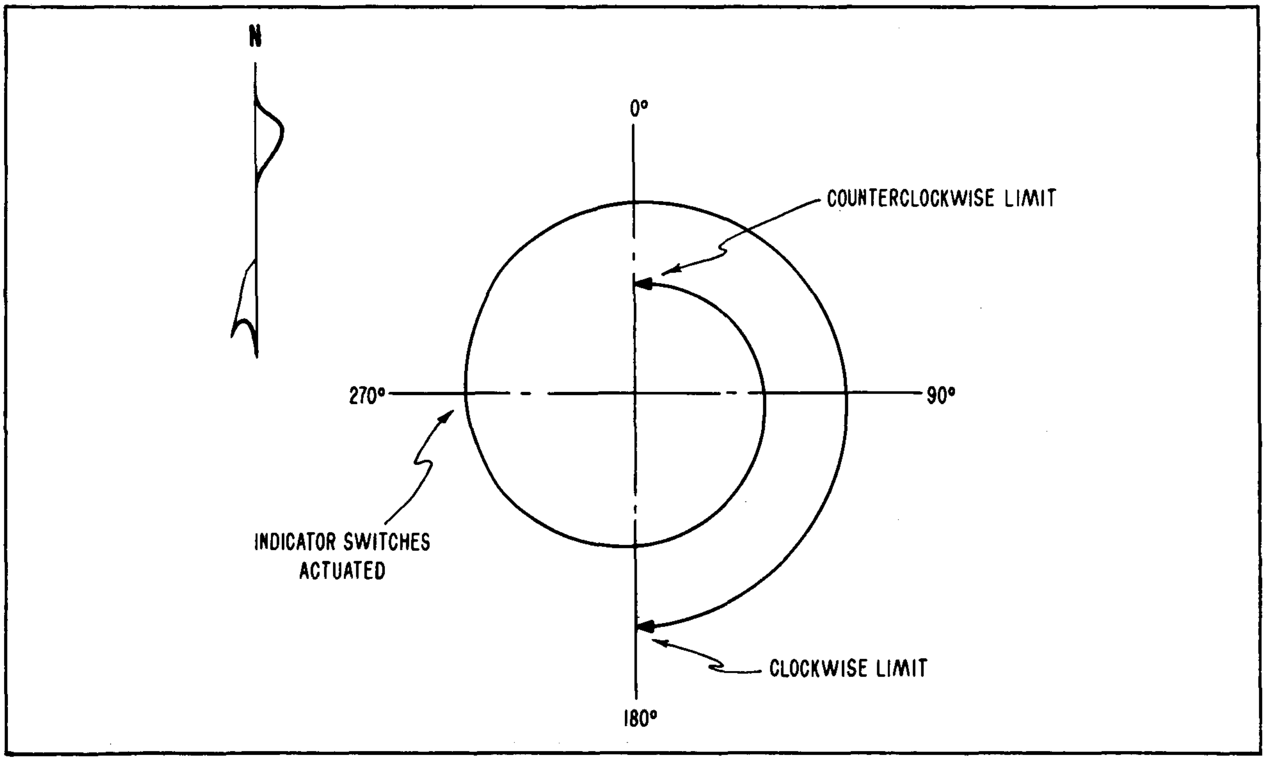


Figure 4-4. Diagram of Antenna Cable Wrap Limits

counterclockwise direction, and continuing in a counterclockwise direction the limit will be reached at zero degrees. So as long as the synchro pointer is on the half of the dial (upper or lower) which is the nearer to the lighted indicator (figures 4-5(A) and 4-5(C)), there is no limit problem and the antenna can safely be turned in either direction. When the synchro pointer is on the half of the dial opposite the lighted indicator (figures 4-5(B) and 4-5(D)), the antenna is near one of its limits of rotation and care must be exercised not to drive it into the limit stop.

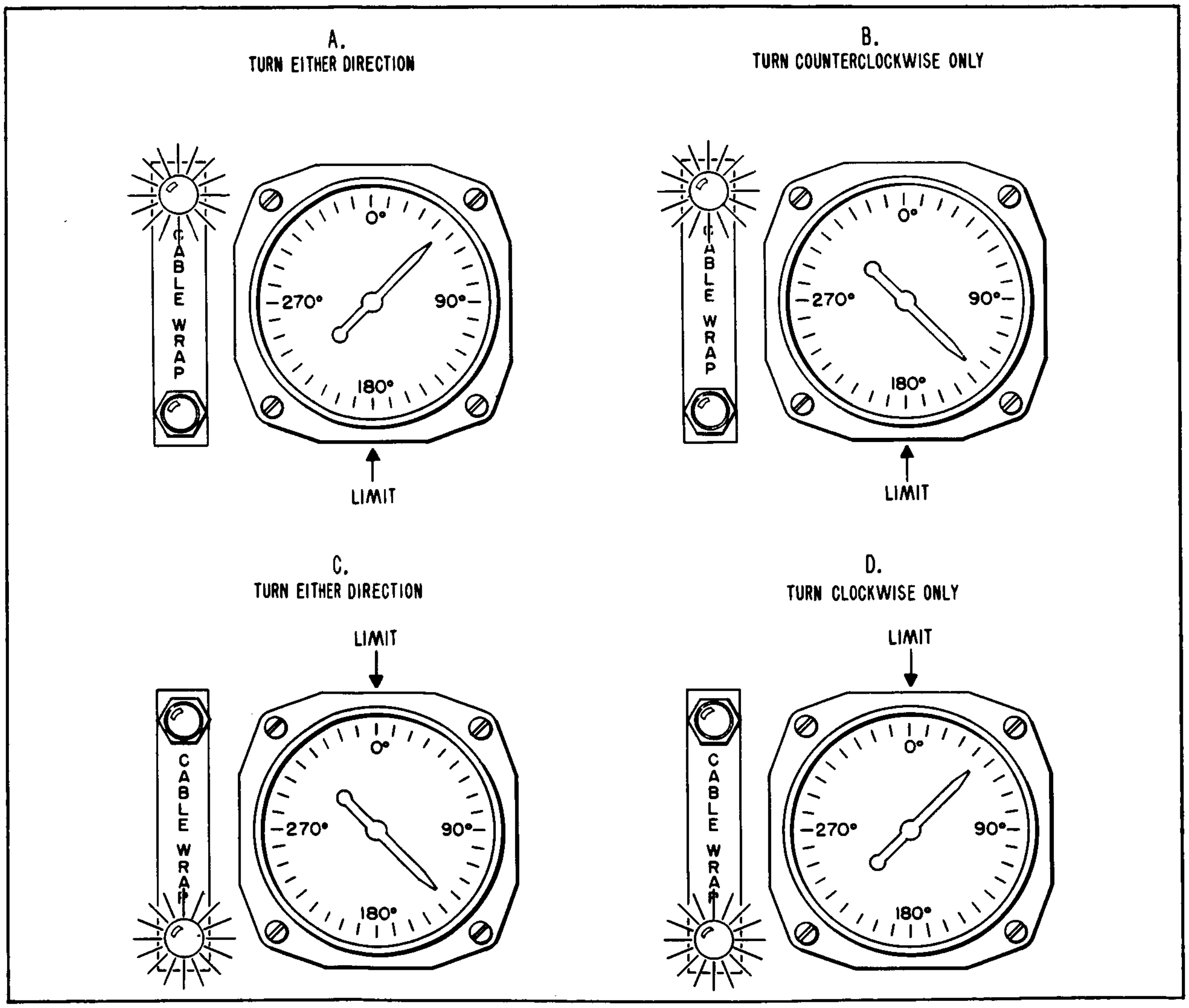


Figure 4-5. Synchro and Lamp Indications of Antenna Bearing Relative to Cable Wrap Limits

2. The operating mode of the transmitting and receiving antenna is indicated by "SLAVED" indicators DS6019 and DS6020 and "MANUAL" indicators DS6021 and DS6022. (See figures 7-1 and 7-6.) Twenty-eight volts d-c is applied to these indicators by the transmitting and receiving antenna mode ("LOCAL-REMOTE") switches, S101 and S102. The two channels, azimuth and elevation, of the transmitting and receiving antenna drive system are independent of one another to the extent that either channel can be operated in the other mode. The "LOCAL-REMOTE" (mode) switches of the antenna are connected to the operating mode indicators on the acquisition data console in such a manner that only when both channels of the antenna drive system are slaved to the acquisition bus is a "SLAVED" indication given on the acquisition data console. If either channel of the antenna drive system is being operated manually, a "MANUAL" indication appears on the acquisition data console. The circuit connections which result in these indications are shown in simplified form on figure 4-6, and completely on figure 7-6. From the illustrations it can be seen that when both the azimuth and elevation "LOCAL-REMOTE" switches are in the "REMOTE" (slaved) position, 28 VDC is applied to "SLAVED" indicator on the acquisition data console. When either "LOCAL-REMOTE" switch is in the "LOCAL" (manual) position, 28 VDC is applied to the "MANUAL" indicator on the console.

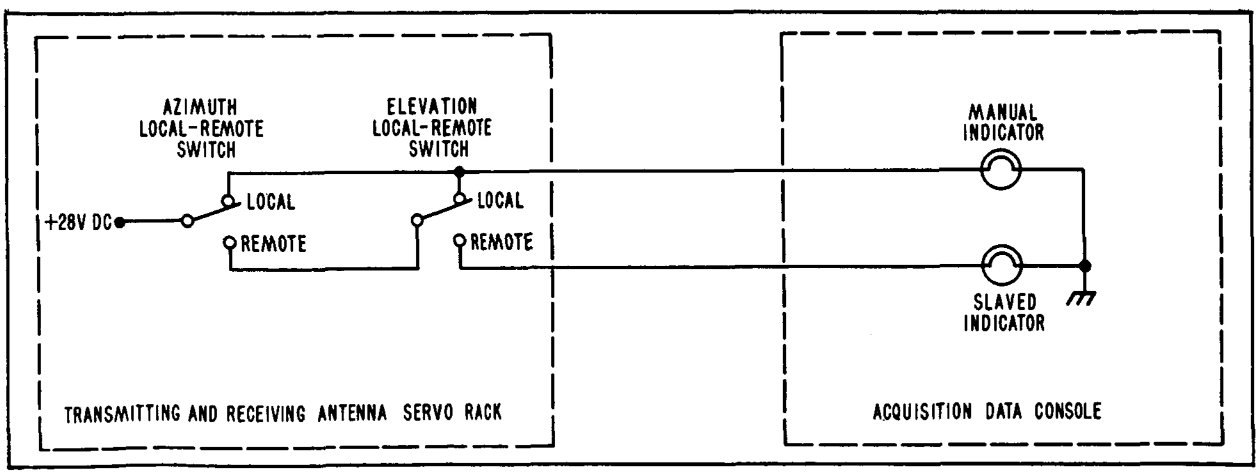


Figure 4-6. Transmitting and Receiving Antenna Mode Indication Circuit, Simplified Schematic Diagram

3. The transmitting and receiving antenna cable wrap indicators on the acquisition data console operate in the same manner as those from the active acquisition aid except that the console indicators are in a circuit which is independent of the cable wrap circuit which lights indicators on the antenna servo rack. (See figures 7-1 and 7-6.) The console indicators are DS6007 (north) and DS6008 (south). They are lit by the closing of switch S204 on the transmitting and receiving antenna pedestal.

(b). <u>SYNCHRO CIRCUITS (Figure 7-1)</u>

There are two sets of synchros on the acquisition data console, one set associated with the active acquisition aid and the other with the transmitting and receiving antenna. (For a description of the principles of operation of synchros, refer to paragraph 4-2. D.) Elevation display data from the active acquisition aid comes into the console on terminal board TB6012 and from there to relative elevation display B6003. B6003 is a synchro receiver. Azimuth display data from the active acquisition aid comes in on terminal board TB6009 and then to relative azimuth display synchro receiver B6005 and in parallel to the stator (S1, S2, S3) of true azimuth display B6001, a synchro differential receiver. The rotor windings of B6001 receive ship's heading synchro data. This data comes from the ship's gyro compass system into the console on terminal board TB6009. Application of antenna relative azimuth to the stator windings of B6001 and ship's heading to the rotor windings results in the rotor turning to the angle of the true azimuth of the antenna. Ship's heading data is also connected to the rotor of the transmitting and receiving antenna true azimuth display differential receiver, B6002. Relative azimuth display data from the transmitting and receiving antenna is connected to the B6002 stator. Thus, like the active acquisition aid true azimuth display, B6002 displays the true azimuth of the antenna with which it is associated. The relative azimuth of the transmitting and receiving antenna is shown by synchro receiver B6006, and relative elevation by synchro receiver B6004. Position data from the active acquisition data console to the transmitting and receiving antenna for slaving the latter. Synchro circuit connections between the acquisition data console and the active acquisition aid and the transmitting and receiving antenna are shown on figures 7-7, 7-8, 7-10, and 7-11.

(c). SIGNAL STRENGTH INDICATION AND AUDIO MONITOR CIRCUITS

1. Signal strength indications from the four telemetry receivers on the ship come into the acquisition data console on terminal boards TB6005 and TB6011 (figure 7-5). The indications are in the form of a d-c voltage whose magnitude is indicative of the strength of the r-f signal input to the telemetry receivers. The d-c indications are applied through calibration potentiometers R6001 through R6004 and series voltage dropping resistors R6005 through R6008 to "SIGNAL STRENGTH" microammeters M6001 through M6004. The face of these meters is calibrated in microvolts on a non-linear scale. The calibration potentiometers are used to adjust the amount of resistance in the circuits so that with signals of known magnitude applied to the inputs of the telemetry receivers, the signal strength meters indicate that signal magnitude. Hence, after proper calibration, the meters on the console indicate the absolute magnitude of the signals being received by the four site telemetry receivers. The receivers (and the console signal strength circuits) are designated by the frequency at which they operate and the antenna to which they are connected. Connected to each of the two steerable antennas on the ship (active acquisition aid and transmitting and receiving) are two telemetry receivers which operate at different frequencies. The designations of the frequencies and antennas is explained in the note on figure 7-5. For a description of how the signal strength meters are used, refer to paragraphs 4-2. C. (2). (f) and (g).

2. Audio signals from the four telemetry receivers come into the active acquisition aid control console on terminal board TB87505 as shown on figure 7-5. Sections A and B of channel selector switch S62301 connect one of these audio signals or

audio from the active acquisition aid receiver (which is detected in the active acquisition aid panadapter) to the active acquisition aid audio amplifier. The amplified audio is connected to a speaker for aural monitoring. The purpose of monitoring audio is to permit the console operator to confirm that a signal strength indication is from an actual telemetry signal and not just noise. In cases of emergency, the audio volume can be used for pointing the antennas. Section C of switch S62301 connects 28 VDC to one of five pilot lamps, DS6001, DS6002, DS6003, or DS6004 on the acquisition data console, or DS62301 on the active acquisition aid control console. One of these lamps is adjacent to each of the signal strength meters, M6001 through M6004 on the acquisition data console and M62303 on the active acquisition aid control console. At any position of switch S62301, the lamp is lit which is next to the signal strength meter whose indication has the same source as the audio which is connected to the loudspeaker. This arrangement provides a correlation between signal strength indication and the audio which is being monitored.

C. ACTIVE ACQUISITION AID

(1). GENERAL

The function of the active acquisition aid is to acquire and track the Mercury capsule and provide slaving data to the transmitting and receiving antenna so that it too is pointed at the capsule. The active acquisition aid has a wide antenna pattern (20 degrees), but tracks with accuracy (±0.5 degrees) sufficient to keep its antenna pattern and that of the transmitting and receiving antenna centered on the target. Because of its wide antenna pattern, the active acquisition aid does not require precise antenna pointing to acquire its target. The antenna is pointed in accordance with the best data available. For initial acquisition, as the capsule comes over the radio horizon, this data is based on computations of the capsule's orbit. For re-acquisition in the event automatic tracking is lost during a pass of the capsule, the best data available is in most cases simply an estimate based on the capsule's position when the tracking was lost. As soon as the capsule comes within its antenna pattern, the active acquisition aid acquires an automatic track and steers itself to boresight; i.e., it points its antenna so that the capsule is in the center of the antenna pattern. Position data (capsule azimuth and elevation) is put out by the active acquisition aid and connected by the acquisition bus to the transmitting and receiving antenna. The transmitting and receiving antenna is slaved to this data and is therefore pointed at the capsule. In addition to its tracking function, the active acquisition aid antenna is used for the reception of HF voice, UHF voice, and telemetry signals. HF voice signals are received by an HF dipole and reflector which are mounted on the active acquisition aid antenna. The received HF signals are fed directly to an HF voice receiver. Telemetry and UHF voice signals are received by the active acquisition aid quad-helix antenna. UHF voice signals are separated from the telemetry by the triplexer and fed to a UHF voice preamplifier (part of the capsule communications system). The two telemetry frequencies go through two stages of r-f amplification in the active acquisition aid and then are fed out to telemetering system equipment.

(2). <u>BLOCK DIAGRAM DESCRIPTION (Figure 4-7)</u>

(a). The active acquisition aid quad-helix antenna receives two telemetry signals transmitted by the capsule. These signals are fed from the helical antenna elements to an r-f bridge composed of four hybrid rings. For each frequency, three outputs from the r-f bridge are used. These outputs are a reference signal (vectorial sum of the signals from the four antenna elements), a signal (azimuth error) which

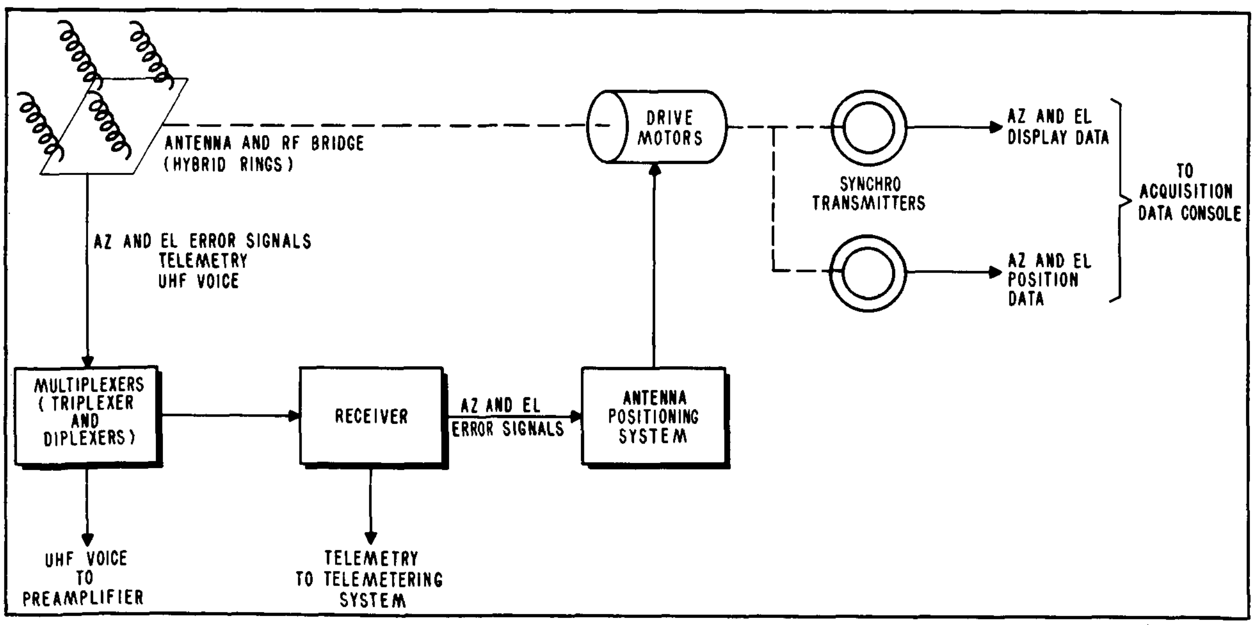


Figure 4-7. Active Acquisition Aid, Simplified Block Diagram

depends on the azimuth displacement of the antenna from boresight, and a signal (elevation error) which depends on the elevation displacement of the antenna from boresight. The derivation of the azimuth and elevation error signals is based on a comparison in the r-f bridge of the signals from the antenna elements. When the antenna is off boresight in azimuth, the signals from the two elements on the right side of the antenna differ in phase from signals from the two elements on the left side; when the antenna is off boresight in elevation, the signals from the two top elements differ in phase from the signals from the two bottom elements. Comparison of these phases yields the error signals.

(b). The azimuth and elevation error signals and the reference signal are fed from the r-f bridge through the triplexer and diplexers, for frequency separation to the receiver. The first and second r-f amplifiers and the first mixer and i-f amplifier of the receiver are in the RF housing unit. The remaining receiver circuits are in the receiver cabinet. The receiver locks onto one or the other of the telemetry frequencies, as selected by switch.

(c). The output of the receiver consists of azimuth and elevation error signals to the antenna positioning system. The antenna positioning system comprises, in essence, electronic and electro-mechanical servo amplifiers and antenna drive motors. This system continuously positions the antenna for minimum or null error signals out of the receiver. Thus, the antenna is kept pointing at the target which is being tracked.

(d). Two pairs of synchro transmitters are mechanically coupled to the antenna. One of these pairs transmits antenna azimuth and elevation position data to the acquisition bus. The other pair transmits azimuth and elevation display data for display on the active acquisition aid control console and on the acquisition data console. The position data transmitters provide the principal output of the active acquisition aid; these transmitters send acquisition and tracking information to the other equipment.

(e). On the meter and switch panel of the control console, there are azimuth and elevation error meters which permit manual tracking with the active acquisition aid in the event that part of the automatic system is inoperative or which fully automatic tracking is not desirable. These meters indicate the amount and direction of antenna pointing error. (The errors indicated by the meters are essentially the same as those supplied to the antenna positioning system during fully automatic tracking.) For manual tracking with the error meters the operator simply turns the manual handwheels on the control console to null the error indicated on the meters.

(f). Manual pointing of the antenna for maximum strength of received signals can be performed with the aid of signal strength meters on the active acquisition aid control console and the acquisition data console. There are five of these meters: four on the acquisition data console and one on the active acquisition aid meter and switch panel. The four on the acquisition data console indicate the strength of the signals received by the four telemetry receivers on the ship. Two of the receivers are connected to the active acquisition aid antenna, and the signal received by them is maximum when the active acquisition aid antenna is pointing at the capsule. The other two telemetry receivers are connected to the transmitting and receiving antenna. The fifth meter, the one on the meter and switch panel, indicates the strength of the signal in the sum channel of the active acquisition aid. The five meters continuously indicate the strength of the signal received by their respective receivers. Audio (telemetry video) also can be monitored, but from only one receiver at a time, as selected by switch. (See figure 7-5 and refer to paragraph 4-2. B. (4). (c). 2.)

(g). For manual tracking by means of received signal strength, the receiver is selected which provides the best signal strength indication and audio. When the selected receiver is the active acquisition aid or one of the two telemetry receivers connected to its antenna, the operator simply turns the handwheels on the console for maximum signal strength as indicated on the appropriate meter. Monitoring of the audio insures that a telemetry signal and not just noise is being received. When one of the telemetry receivers connected to the transmitting and receiving antenna is selected, the transmitting and receiving antenna must be slaved through the acquisition system to the active acquisition aid. Then, turning the handwheels on the active acquisition aid control console positions the transmitting and receiving antenna. Under this condition, the active acquisition aid operator turns the handwheels, and thereby remotely positions the transmitting and receiving antenna, for maximum signal indication from the selected receiver.

D. SYNCHROS

(1). TRANSMITTERS AND RECEIVERS

(a). A standard synchro transmitter or receiver, such as is used in the acquisition system, may be considered as a single phase transformer with a rotatable primary and stationary, wye-wound secondary. Accordingly, the primary winding is called the rotor, and the secondary windings are called the stator. The two terminals of the rotor windings are designated R1 and R2, and the terminals of the three stator windings are designated S1, S2, and S3.

(b). A reference, or excitation voltage (115 VAC, 60 cycles for the synchros in the acquisition system) is applied to the rotor of a synchro. (See figure 4-8.) This reference voltage applied to the rotor of the synchro induces voltages in the stator windings. The magnitude of the voltage induced in a given stator winding depends on the angle which the rotor makes with that stator winding, and the phase angle of the voltage in a stator winding with respect to the rotor voltage is always zero or 180 degrees. The voltages in the windings of a synchro stator are shown in figure 4-9. The curves in the illustration are plots of the voltage magnitudes and phase against the angle of the rotor. The voltage across each stator winding (i. e., from the winding terminal to the common connection of the three windings) varies from 52 VAC (rms) of one phase polarity through zero to 52 VAC of the opposite phase polarity as the rotor is turned. Due to the way the rotor and

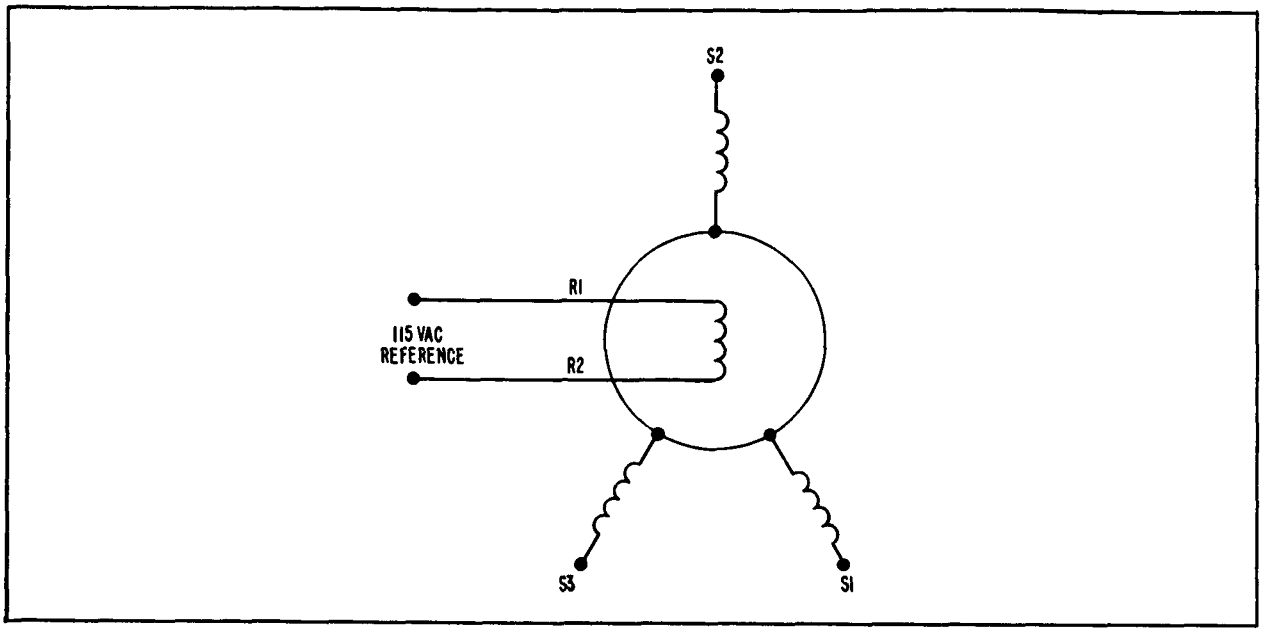


Figure 4-8. Synchro Transmitter or Receiver, Schematic Diagram

stator windings are arranged on a synchro, these curves are sinusoidal. However, they should not be confused with timegraphs of sinusoidal voltages. All of the voltages in a synchro system are a-c, they are either in phase or 180 degrees out of phase with each other, and their effective (rms) values vary with the angle of the rotor as shown on the illustration.

(c). In practice, no external connection is made to the common connection of the three stator windings, and the synchro system stator voltages are taken between the three pairs of windings: S2 and S1, S2 and S3, and S1 and S3. The voltage magnitude and phase between these pairs of windings is shown in figure 4-10 for varying rotor angles.

(d). The simplest form of synchro system consists of a transmitter and a receiver. A transmitter and a receiver which are suitable for use in the same system generally are electrically identical, but differ somewhat mechanically. The most notable mechanical difference is the use of a damper on the receiver in order to prevent it from oscillating. The transmitter, being mechanically coupled to an antenna or

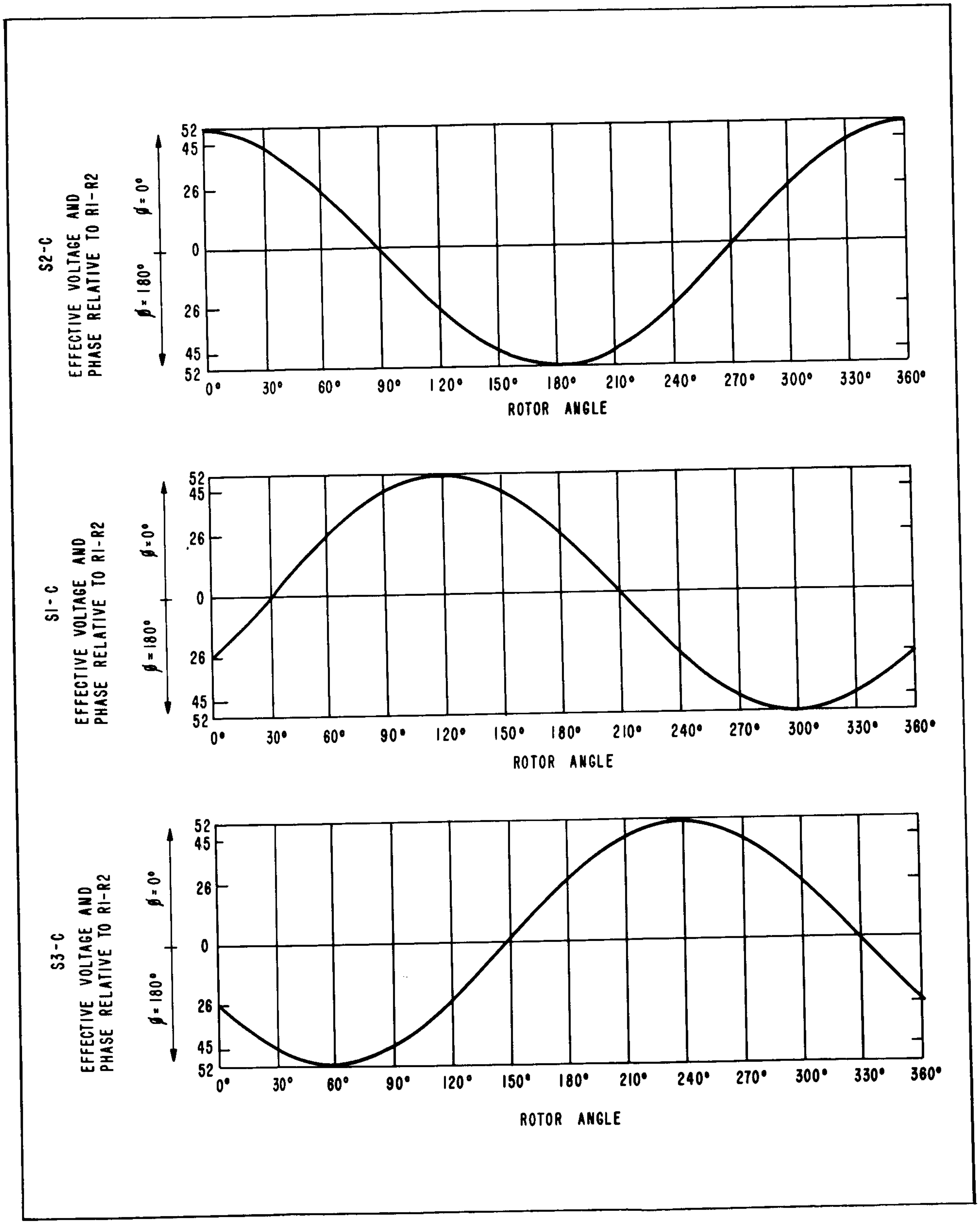


Figure 4-9. Voltages in Synchro Stator Windings

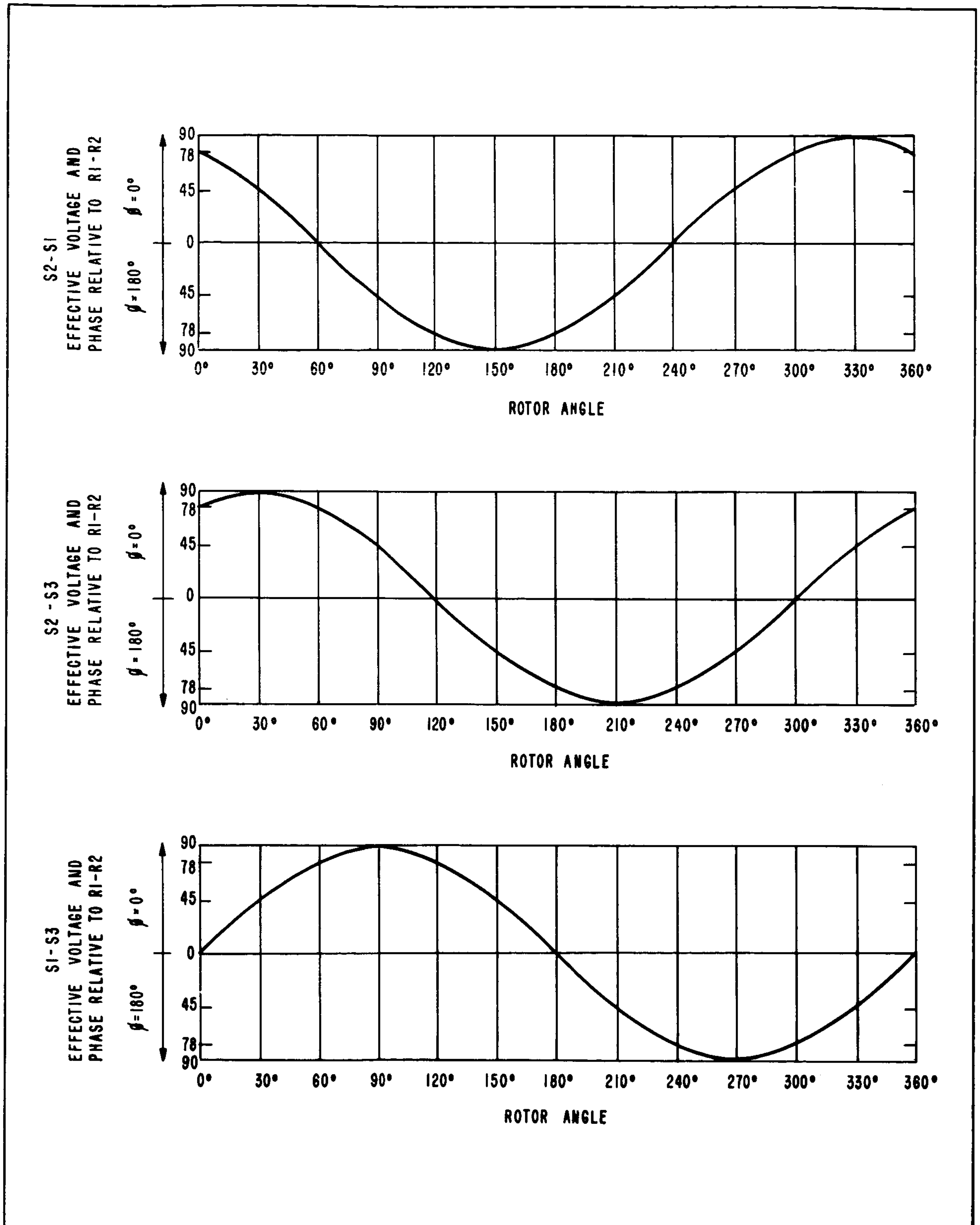


Figure 4-10. Voltages between Synchro Stator Windings

handwheel through a gear train requires no damper. Hence, if mechanical coupling can be arranged, a receiver can be used as a transmitter, but a transmitter generally cannot be used as a receiver.

(e). The manner in which a synchro system works is illustrated in figures 4-11 and 4-12. The stator windings of the transmitter are connected to the corresponding windings on the receiver; S1 to S1, S2 to S2, and S3 to S3. The rotor windings of the transmitter and receiver are connected in parallel and are supplied by 115 VAC reference.

Note

> All of the rotor windings in a synchro system must be connected to a common reference voltage source. Other wise, phase differences between voltage sources will cause inaccuracies in the system.

With the reference voltage applied and both of the rotors at zero degrees, as shown in figure 4-11, voltages in the stator windings are 52 VAC for the S2 windings and 26 VAC each for the S1 and S3 windings.

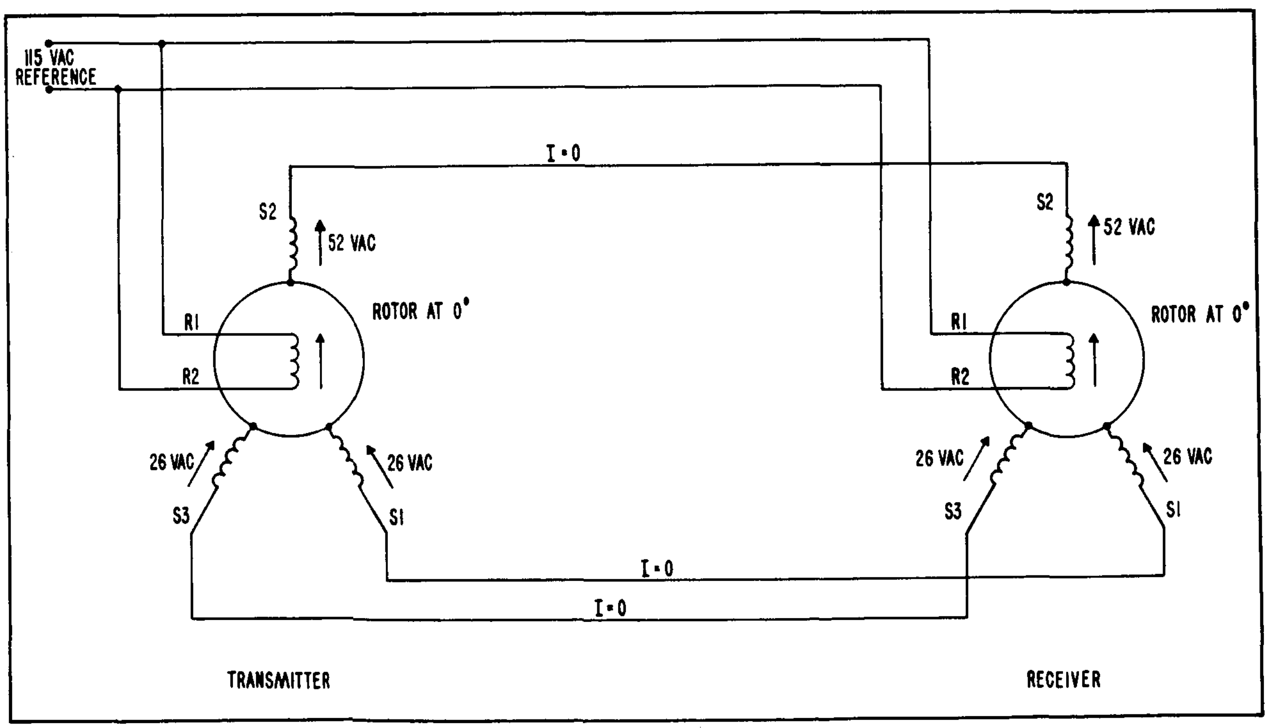


Figure 4-11. Simple Synchro System with Transmitter and Receiver Rotors at the same Position, Schematic Diagram

The arrows on the illustration adjacent to the windings indicate relative instantaneous current direction (relative phase). As can be seen from figure 4-11, with both the transmitter and receiver rotors in the zero position, the magnitudes of the voltages induced in the stator windings of the transmitter and receiver are the same, and the phases are such that no current flows through the windings. With no current in the windings, no torque is developed and both synchros remain at rest. This condition of dynamic balance (voltages and phases such that no current flows in the stator windings) exists whenever, but only so long as, the rotors of the transmitter and receiver are at the same angular position.

(f). If the synchro receiver is held at one position and the transmitter turned to another position, unbalanced stator voltages are developed and current flows in the windings. An example of this condition is shown in figure 4-12. The rotor of the transmitter is turned to 30 degrees, inducing stator voltages of the magnitudes and relative phases shown on the illustration. (For the magnitude and relative phase of the induced stator voltages at any position of the rotor, see

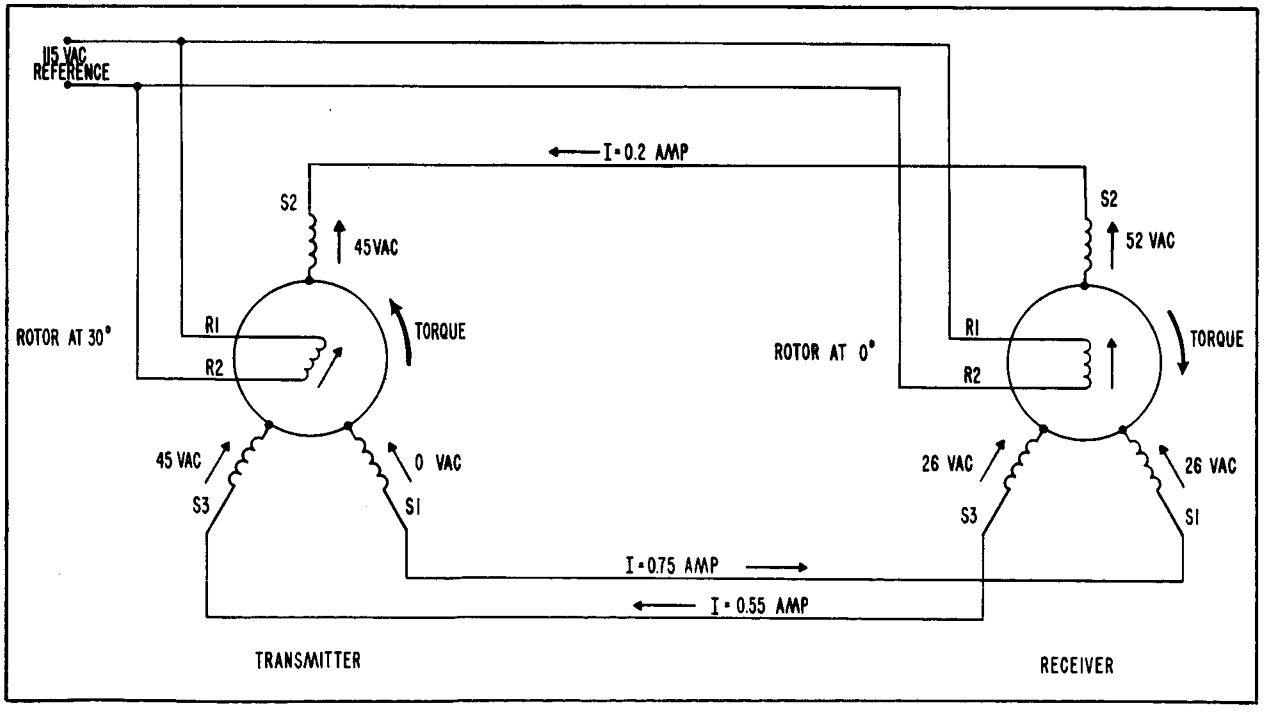


Figure 4-12. Simple Synchro System with Transmitter and Receiver Rotors at Different Positions, Schematic Diagram

figure 4-9.) The rotor of the receiver, however, is at a different position, zero degrees, and the voltages induced in its stator windings are different from those in the stator of the transmitter. Currents with the relative phases shown flow in the stator windings. The magnitudes indicated for the currents are typical values. These currents cause torque to be applied to the rotors of the synchros and both of the rotors try to turn. Under the conditions shown on figure 4-12, the transmitter rotor will try to turn in a counterclockwise direction and the receiver rotor in a clockwise direction. The transmitter rotor, when it is mechanically coupled to an antenna or a handwheel, is not free to turn, but the receiver rotor is free to turn. Thus, the receiver rotor turns to the same position as the transmitter rotor and the system comes to dynamic rest. In the same manner, if the transmitter rotor is turned to some new position, the receiver rotor follows. The synchros used in the acquisition system have sufficient sensitivity that as long as reference voltage is applied and the units are operating normally, a receiver will always follow the transmitter to which it is connected within a small fraction of a degree. The receiver is always at virtually the same position as the transmitter, regardless of whether the transmitter is stationary or is being turned. Hence a pointer or dial attached to the receiver rotor provides an indication of the angular position of the device — in most cases an antenna — to which the transmitter rotor is coupled.

(g). Either a single receiver or several receivers in parallel may be driven by a single transmitter. The acquisition system employs both of these arrangements.

(h). A variety of nomenclature is applied to synchros. The most common of these are listed and explained below:

1. Torque receiver (TR): a synchro receiver.
2. Torque transmitter (TX): a synchro transmitter which can drive a relatively large mechanical load (on the receiver or receivers connected to the transmitter).
3. Control transmitter (CX): A synchro transmitter which can

drive only a relatively small mechanical load (on the receiver or receivers connected to the transmitter).

Note

> Both torque transmitters and control transmitters are synchro transmitters as described in the previous paragraphs, and except for the amount of load they can drive, they are the same.

4. Synchro generator: a synchro transmitter.
5. Synchro motor: a synchro receiver.
6. Differential receiver: this device is described in the following paragraph.
7. Control transformer (CT): this device is described in paragraph 4-2. D. (3).
8. Selsyn, autosyn: trade names for synchros.

(2). DIFFERENTIAL RECEIVERS

(a). The stator of a synchro differential receiver is basically the same as that of a transmitter or receiver, but the rotor differs. In a differential the rotor consists of three wye-connected windings, as shown on figure 4-13. A pointer is mounted on the rotor to indicate the angle to which it is turned.

(b). The function of the differential receivers in the acquisition system is to add the angles of antenna relative azimuth and the ship's heading in order to produce an indication of antenna true azimuth. The manner in which this is accomplished is illustrated by figure 4-14. The two angles to be added are in synchro form: antenna relative azimuth from the display data transmitter, whose rotor is mechanically coupled to the antenna and ship's heading from a transmitter whose rotor is driven by the ship's gyro compass system. The antenna display data transmitter stator is connected to the differential stator, and the ship's heading transmitter stator is connected to the differential rotor. Because voltages induced from the transmitter rotors exist between the stator windings of each of the two transmitters,

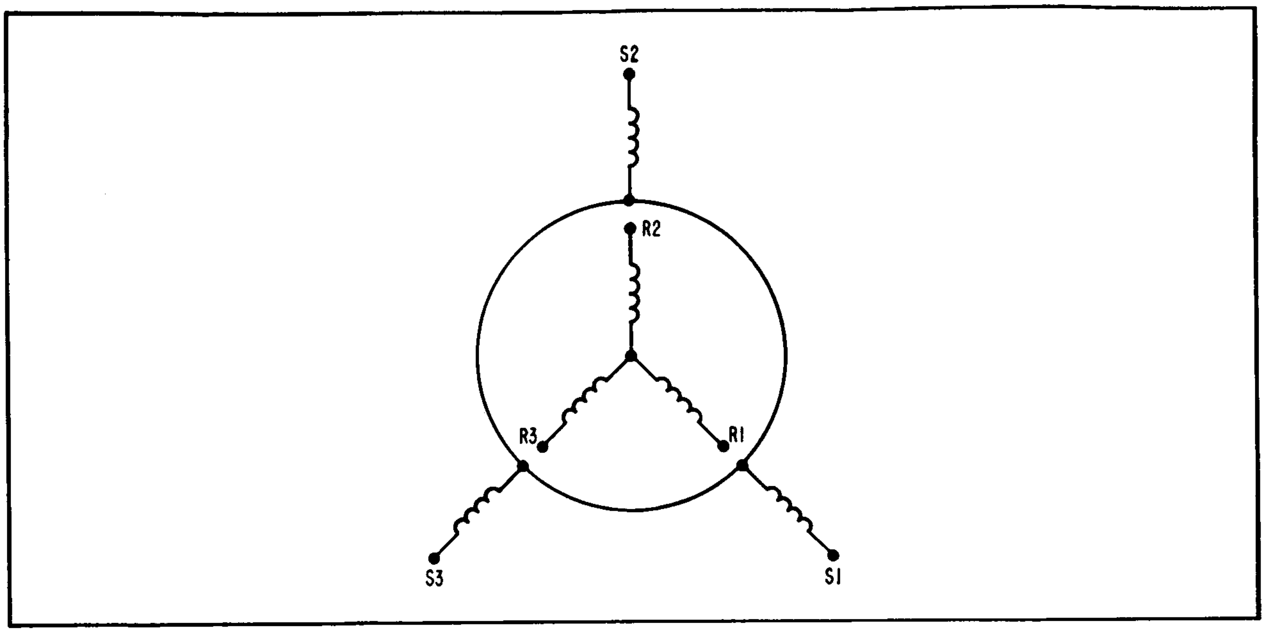


Figure 4-13. Synchro Differential Receiver, Schematic Diagram

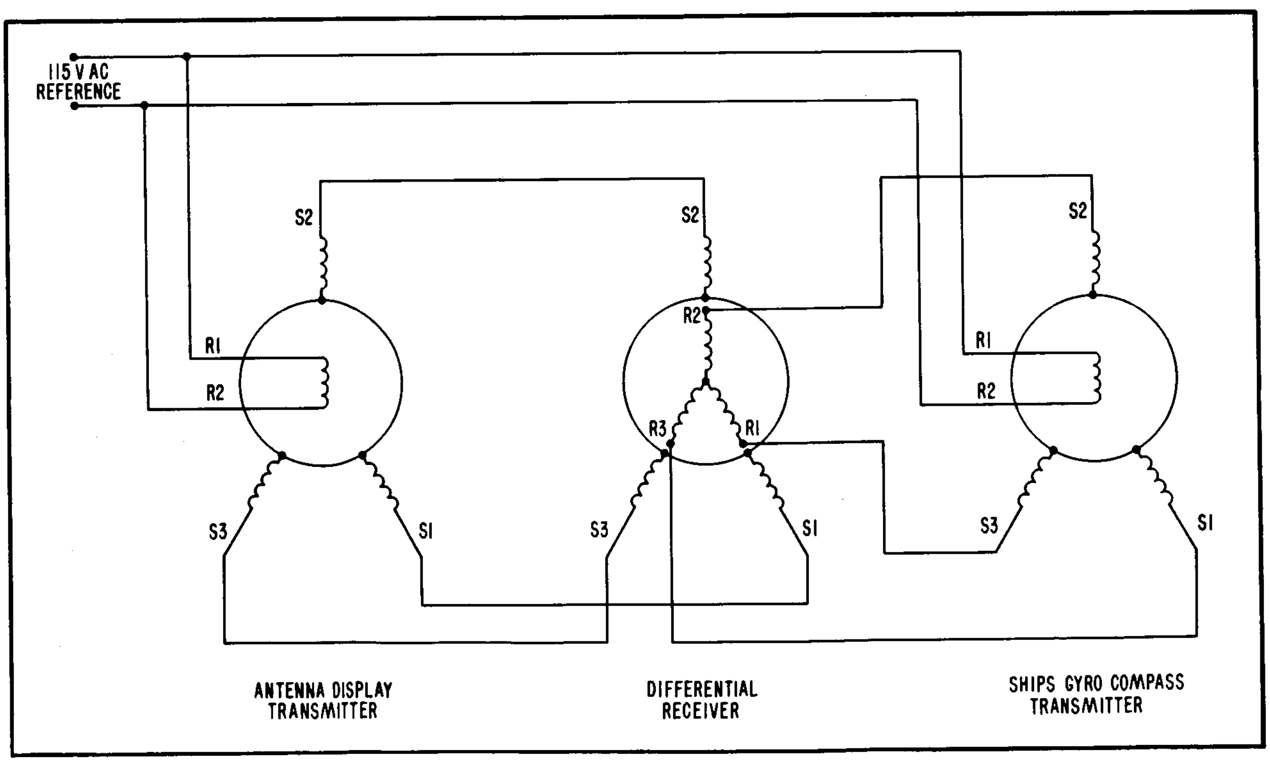


Figure 4-14. Synchro Differential Receiver Connections to Indicate Antenna True Bearing, Schematic Diagram

currents flow in both the stator and rotor windings of the differential. The net field set up by the differential stator current has the same angular direction relative to the differential stator, which cannot turn, as does the rotor of the antenna transmitter to its stator. The net field set up by the current in the differential rotor has the same angle relative to the rotor as does the rotor of the ship's heading transmitter to its stator. The rotor of the differential, which is free to turn, turns to the position where the net fields of the differential stator and rotor are in line. Under this condition, the rotor is physically at the angle which is the sum of the angles of the two transmitter rotors. Hence, the differential pointer indicates the true azimuth of the antenna.

(3). CONTROL TRANSFORMERS

(a). The control transformer is a type of synchro unit widely used in automatic control systems. Its function is to supply an a-c voltage whose magnitude and phase polarity depend on the difference between the angular position of its rotor and the rotor of the synchro transmitter which is connected to it. Control transformers are used in various places in the antenna positioning systems which are part of or are connected to the acquisition system.

(b). Control transformers are similar to synchro transmitters and receivers, but differ from them in several important respects:

1. The rotor winding of a control transformer is never connected to an a-c supply and therefore induces no voltage in the stator windings. As a result, the stator current is determined only by the impedance of the windings, which is relatively high, and it is not appreciable affected by the rotor's position. (A matched set of delta-connected capacitors are connected across the stator leads near the control transformer. These capacitors correct the lagging power factor of the control transformer windings and reduce the current drawn from the synchro transmitter.) Also, there is no appreciable current in the rotor, and the rotor does not tend to turn to any particular position when voltages are applied to the stator. The rotor of a control

transformer is always turned by some mechanical device, such as an antenna. (Or more specifically, by gearing between an antenna and the control transformer.)

2. The zero position of a control transformer is that at which the rotor is at right angles to the S2 stator winding. (See figure 4-15.) Note that this zero position differs by 90 degrees from that of a transmitter or receiver (figure 4-11).

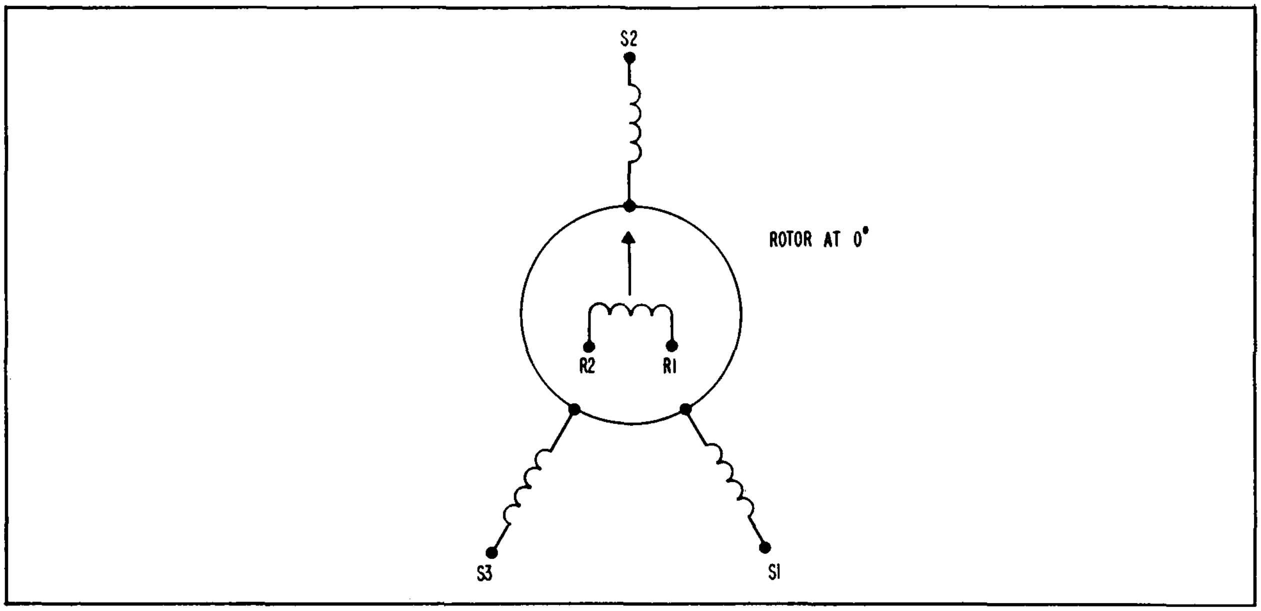


Figure 4-15. Control Transformer, Schematic Diagram

(c). The manner in which a control transformer is connected in a system is shown in figure 4-16. The stator windings of the control transformer are connected to the corresponding stator windings of a synchro transmitter. The rotor of the control transformer is usually connected to a servo amplifier. With a reference voltage (115 VAC) applied to the rotor of the transmitter, voltages are induced in the stator windings of the transmitter. These voltages are representative, by magnitude and phase polarity, of the angular position of the rotor. Since the stators of the control transformer and transmitters are connected, currents flow in the windings, and if the control transformer rotor is at any position except the same or 180 degrees different from that of the transmitter rotor, voltage is induced in the control transformer rotor.

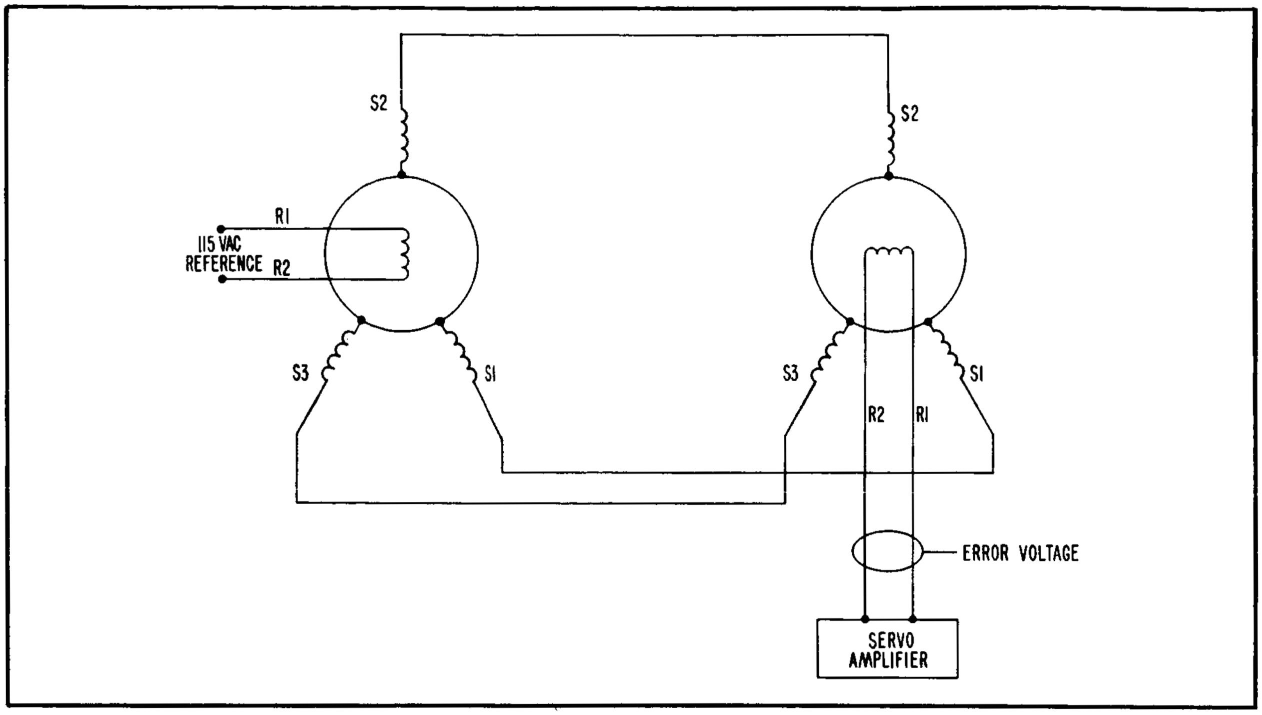


Figure 4-16. Control Transformer and Synchro Transmitter Connections, Schematic Diagram

(d). The voltage induced in the control transformer rotor when it is at a position different from the transmitter rotor depends in magnitude and phase polarity on the angular difference between the two rotors. The voltage variation for 360 degrees of angular difference between the positions of the two rotors is shown on figure 4-17. Note that the rotor voltage has two null points: at positions which are zero and 180 degrees different from the position of the transmitter rotor. When the control transformer rotor is between zero and 180 degrees relative to the transmitter rotor (voltage curve above zero line on figure 4-17), the control transformer rotor voltage is of one phase; between 180 and 360 degrees (voltage curve below the line on figure 4-17), it is of the opposite phase.

(e). For a description of how control transformers are used, refer to paragraph 4-2. E.

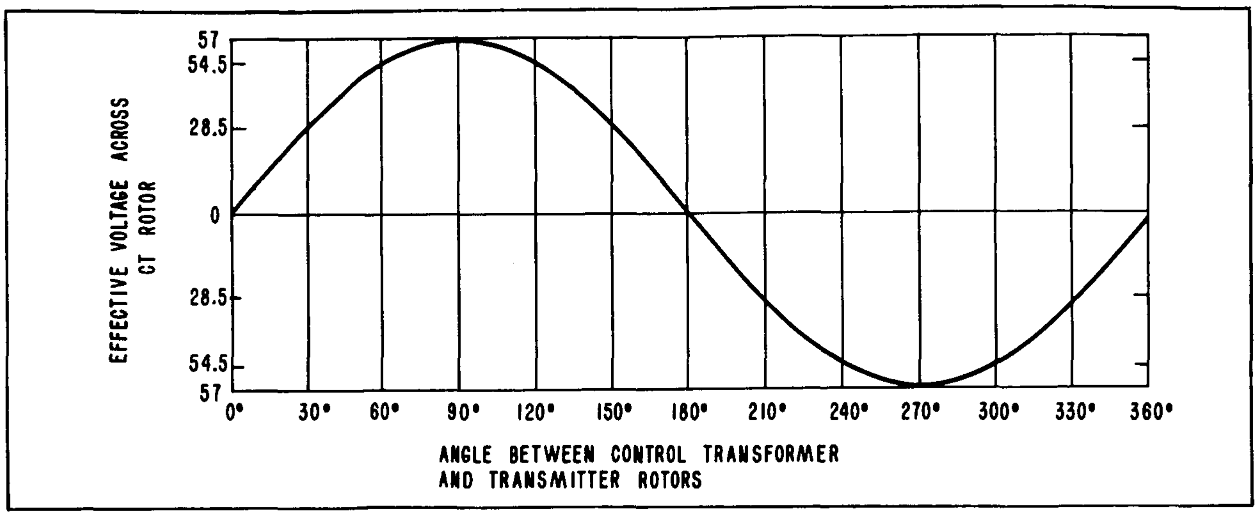


Figure 4-17. Voltages in Rotor Winding of Control Transformer

E. TYPICAL SERVO SYSTEMS UTILIZING SYNCHROS

In the acquisition system and the equipment associated with it there are a number of servo systems which utilize synchros. A simplified version of a servo system of this type is described in this paragraph to provide a basic understanding of how mechanical position data is converted to electrical form, transmitted over a distance and converted back to mechanical form. Figure 4-18 illustrates such a system.

(1). The principal elements of the system are a mechanical input (the handwheel on figure 4-18), a mechanical/electrical converter (the synchro transmitter), an electrical/mechanical converter (the servo loop consisting of the control transformer, the servo amplifier, and the servo motor), and a mechanical output, or load (the antenna).

(2). The output of the synchro transmitter is a function of the position of its rotor, which is mechanically coupled to the handwheel. The output of the synchro transmitter is connected to the control transformer, whose rotor may or may not be at the same angular position as that of the transmitter. (Refer to paragraph 4-2. D. for a description of the operation of synchro transmitters and control transformers.) When the control transformer rotor is not at the same position as the rotor of the transmitter, a voltage is developed in the control transformer rotor winding. The magnitude and phase polarity of this voltage depend on the angular difference between the positions of the two rotors. This voltage, the error signal of the servo loop,

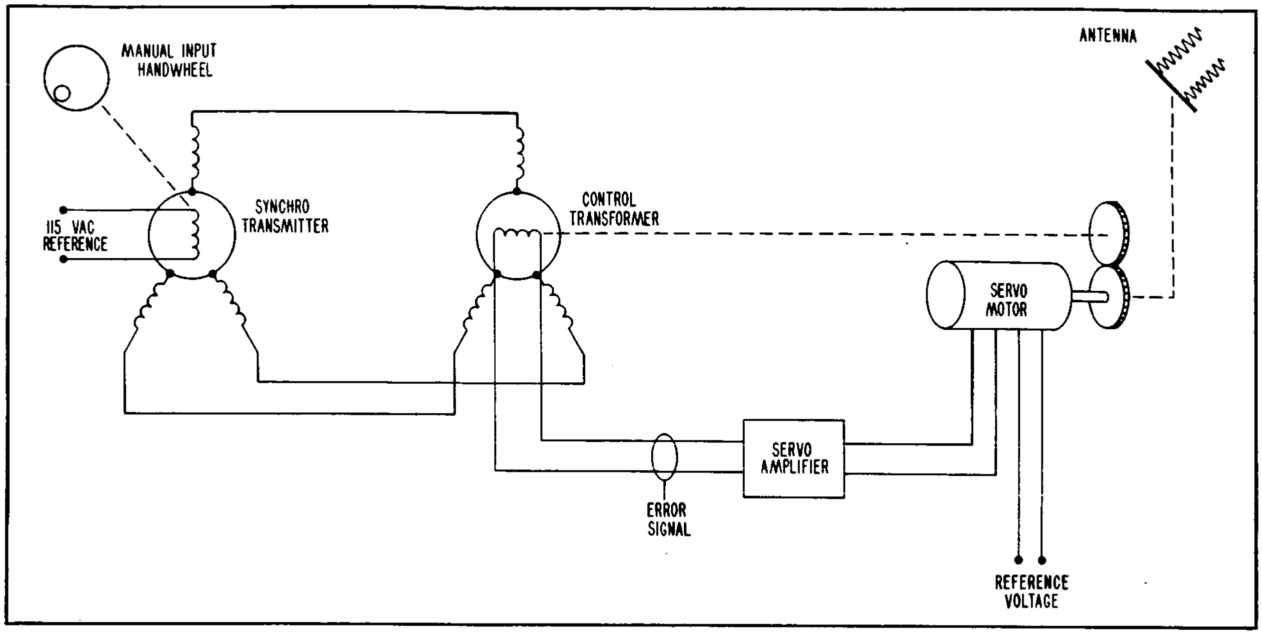


Figure 4-18. Typical Servo System Utilizing Synchros, Simplified Schematic Diagram

is applied to the servo amplifier, where it is amplified and applied to the variable-phase field winding of a two-phase motor. A reference voltage is applied to the fixed-phase field of the motor. The direction of rotation of the motor depends on the phase of the error signal (relative to the reference voltage), and the speed of rotation of the motor depends on the magnitude of the error signal. When no error signal is applied, the motor does not rotate. The motor armature is coupled through gearing to the rotor of the control transformer and to the mechanical load, in this case an antenna. The gearing and phase of signals in the servo loop are so arranged that whenever there is an error signal developed across the rotor of the control transformer, the motor turns in the direction which results in a reduction of the magnitude of the error. Stated another way, the motor drives the rotor of the control transformer so that it is always at very nearly the same position as the rotor of the synchro transmitter. Since the antenna is also driven by the motor, it too is kept at virtually the same position as the transmitter rotor.

(3). The servo systems actually used in the acquisition system and associated equipment are generally more elaborate than that just described, but the principal elements of the systems are the same. For instance, the active acquisition aid uses an amplidyne and a d-c servo motor in each channel of its antenna positioning system. The d-c servo motor, however, has exactly the same basic function as the two-phase, a-c motor on figure 4-18, and the amplidyne functions simply as an additional, two-stage servo amplifier.

SECTION V
SYSTEM MAINTENANCE

5-1. GENERAL

This section includes information, instructions and procedures for preventive maintenance, trouble shooting, adjustments and repair, lubrication, special tools, and test equipment. In the majority of cases, detailed information is given only for the acquisition data console and its components; for other equipment in the system, system-level and general information is given. For detailed information on the other equipment, refer to the applicable equipment manuals, listed in table 1-II.

WARNING

Antenna drive power cutoff switches and warning lights are mounted below the platforms of the active acquisition aid antenna and the transmitting and receiving antenna. (Refer to Section II for the location of the switches.) When drive power is applied to the pedestal, the warning light is lit. The switch should be turned off (thus removing drive power from the pedestal) before going onto the antenna platform for maintenance or repair. For a schematic diagram of the active acquisition aid antenna safety circuit, which includes a cutoff switch and warning light, see figure 7-9.

5-2. PREVENTIVE MAINTENANCE

A. PREVENTIVE MAINTENANCE SCHEDULE

Table 5-I outlines the preventive maintenance procedures which are to be performed on all of the equipment in the acquisition system. Detailed procedures are discussed in paragraph 5-2.B. and the equipment manuals.

B. PREVENTIVE MAINTENANCE PROCEDURES

(1). PAINTED SURFACES

Painted surfaces which have corroded should be sanded to remove all of the corroded material and then painted with a color which matches the original. If

TABLE 5-I. PREVENTIVE MAINTENANCE SCHEDULE

Equipment	Maintenance To Be Performed	Refer To
	DAILY	
Active Acquisition Aid	Check cover plates on pedestal for watertightness.	Equipment manual
	Check all strip heaters for proper operation.	Equipment manual
	Check azimuth and elevation limit switches for proper operation.	Equipment manual
	Operate the pedestal both in azimuth and elevation for several minutes in order to keep the gearing well lubricated.	-
	WEEKLY	
All	Check for corrosion of painted and plated surfaces. Clean and resurface all corroded areas.	Paragraphs 5-2.B.(1). and (2).
	Check mechanical condition of switches to see that they are not loose or sluggish in their action. Replace any that appear likely to become defective.	-
All except Acquisition Data Console.	Check the lamps or bulbs in all indicators. Replace any that are burned out.	Equipment manual
Acquisition Data Console.	Check and replace any burned out lamps in the 28 VDC power supply indicators.	Paragraph 3-2.B.
	Check and replace any burned out lamps in all of the indicators not covered by the previous step.	Paragraph 3-4.A.
Active Acquisition Aid	Check for the presence of water in the azimuth oil sump.	Equipment manual
	Check for the presence of water in the elevation gear compartment.	Equipment manual
	Check the oil level in the azimuth oil reservoir.	Equipment manual

TABLE 5-I. PREVENTIVE MAINTENANCE SCHEDULE (Cont.)

Equipment	Maintenance To Be Performed	Refer To
	MONTHLY	
All	Perform general cleaning as necessary. Wipe off, vacuum off, or blow out dust, dirt and sand. Clean dial plates (glass) on synchro displays.	-
	Check and correct as necessary the general condition of equipment. Check cables and wiring for worn or frayed insulation, check connectors to see that they are free from corrosion and are tight, and check terminal board connections for tightness.	-
Active Acquisition Aid	Check the operation of the azimuth oil sump.	Equipment manual
	Check the oil level in the elevation oil reservoir.	Equipment manual
	Check the cleanliness of the lubricants in the antenna control unit.	Equipment manual
	Check the azimuth and elevation drive motor breakaway currents.	Equipment manual
	Check the conditions, placement, and dress of cables which wrap as the pedestal turns.	Equipment manual
	BIMONTHLY	
Active Acquisition Aid	Check the operation of the elevation oil pump.	Equipment manual
	Check the azimuth and elevation amplidyne and drive motor brushes and commutators.	Equipment manual
	Check the amount of backlash in the pedestal drive gearing.	Equipment manual
	SEMI-ANNUALLY	
Active Acquisition Aid	Check the mechanical friction of the pedestal (torque required for pedestal azimuth and elevation movement).	Equipment manual

TABLE 5-I. PREVENTIVE MAINTENANCE SCHEDULE (Cont.)

Equipment	Maintenance To Be Performed	Refer To
	YEARLY	
Active Acquisition Aid	Disassemble azimuth and elevation amplidynes and clean and lubricate bearings and air circulating system.	Equipment manual
	Disassemble azimuth and elevation drive motors and check the condition of the bearings.	Equipment manual

matching paint is not available, apply any available paint. When matching paint is obtained, paint non-matching areas for the sake of appearance.

(2). PLATED SURFACES

Corrosion of plated surfaces (cadmium, nickel or other) should be removed with sandpaper or emergy cloth and sprayed or brushed with a clear lacquer. If a clear lacquer is not available, the corroded areas should be painted to prevent further corrosion until lacquer can be obtained.

5-3. TROUBLE SHOOTING

This paragraph provides information to aid in the isolation and correction of troubles in the acquisition system. It is concerned primarily with those malfunctions which affect the transmission of acquisition information; for information on a malfunction which affects only an individual piece of data source or data-using equipment, refer to the applicable equipment manual. Since the d-c indication and synchro portions of the acquisition system are essentially independent of one another, they are treated separately in the following discussions.

A. D-C INDICATIONS

The d-c indication circuits in the acquisition system are simple and straightforward and should pose little difficulty in trouble shooting. When a d-c indicator fails to operate properly, refer to the diagrams in Section VII (particularly figure 7-6) and to the applicable portions of paragraph 5-4 for information on isolating and ascertaining the source of trouble. The source of the trouble will, of course, in most instances be obvious on examination of the circuits involved. For information on inter-equipment wiring, refer to Section II, and for information on the internal wiring of equipment other than the acquisition data console, refer to the applicable equipment manual.

B. SYNCHROS

This paragraph comprises three sections: criteria for distinguishing actual troubles (repair or replacement required to correct the malfunction) from those malfunctions which can be corrected by adjustment, system trouble analysis, and circuit trouble analysis. The material on system trouble analysis provides information to aid in isolating the trouble to a particular circuit, or portion of the system. The material on circuit trouble analysis will aid in further isolating and determining the exact nature of the trouble. Both the system and circuit trouble analyses are concerned with actual troubles, not misadjustments. For synchro adjustment procedures, refer to paragraph 5-4.B.

(1). CRITERIA FOR DISTINGUISHING TROUBLE FROM MISADJUSTMENT

A synchro device is not operating properly when it does not accurately, rapidly, and smoothly transmit or follow the angular information which is fed into it. If a synchro has an error in the information it puts out, but the error is small and constant and the output of the synchro follows the input smoothly and rapidly, the cause of the improper operation is most likely misadjustment. (For a transmitter the input is mechanical and the output is electrical. For a receiver the input is electrical and the output mechanical. For a control transformer there are two inputs, one electrical and one mechanical, and one output, electrical.) If the synchro follows the input but with changing error, does not follow the input, spins, oscillates, hunts, follows erratically, has a large error (about 60 degrees or more), hums, overheats, or exhibits a combination of these or similar symptoms, the cause is most likely an actual trouble, either in the synchro being observed, another synchro connected to it, or the circuits between the two.

(2). SYSTEM TROUBLE ANALYSIS

Trouble shooting of the synchros in the acquisition system requires a thorough knowledge of the basic principles of synchros and the particular way in which they are used in the system. (Refer to Section IV.) With this knowledge it should be evident from the pertinent schematics (figures 5-10 and 5-11 in addition to the section VII drawings) what the possible causes are for any given trouble. However, keep the following points in mind:

(a). A defective synchro can degrade the performance or cause abnormal operation of any or all synchros which are connected directly to it; for instance, where two receivers (or a receiver and a control transformer) are wired in parallel, a defect in one of them may cause abnormal operation of both. In cases where several synchros have abnormal operation, it will help in isolating the trouble to disconnect, one at a time, each of those involved to see which is affecting the operation of the others.

(b). The reference voltage (rotor) circuits are virtually the only circuits the azimuth and elevation channels have in common. If abnormal operation shows up in both azimuth and elevation channels in a portion of the acquisition system, look for trouble in the reference voltage circuits.

(c). Troubles that show up just after installation or replacement of synchro units are most likely due to incorrect wiring connections, not to defective units.

(d). When a trouble occurs, be sure to check all connecting circuits very thoroughly. Synchros themselves, although delicate instruments, are generally very reliable and trouble-free devices.

(3). CIRCUIT TROUBLE ANALYSIS

Once it has been determined that the source of trouble is in a particular circuit or portion of the system, circuit trouble analysis may be performed by one or a combination of the following means:

(a). Use of the synchro trouble shooting chart, figure 5-1: This chart graphically shows the symptoms and causes of most of the common synchro troubles, including incorrect wiring connections.

(b). Checks of connecting circuits: All of the circuits between synchros in a malfunctioning portion of the system should be checked in accordance with the applicable portions of paragraph 5-4 and the interconnecting circuit diagrams in Section VII.

(c). Synchro voltage checks: In some instances it may not be possible to turn the suspected synchros as is necessary when using figure 5-1. In such instances the synchro voltages can be checked: transmitter and receiver rotor voltage should always be 115 VAC. Transmitter, receiver and control transformer stator voltages should be as shown by the curves of figure 4-10. Control transformer rotor voltage should be as shown in figure 4-17.

C. SIGNAL STRENGTH INDICATIONS AND AUDIO CIRCUITS

Trouble shooting of these circuits may be performed with the aid of figure 7-5. For information on the audio amplifier, refer to the active acquisition aid equipment manual. For information on the internal circuits of the telemetry equipment, refer to the Telemetering System Manual, MS-106.

5-4. ADJUSTMENTS AND REPAIR

A. GENERAL

This paragraph describes, on an individual basis, adjustment and repair procedures for synchros, the 28 VDC power supply, relays, and switch and indicator assemblies. For detailed information on other components of the acquisition system, see the applicable equipment manuals. The repair procedures given here are based on the assumption that a particular component, such as a relay, switch or synchro, is known or suspected to be malfunctioning. The procedures are for the isolation and correction of the specific cause of trouble. For general, or system, trouble shooting procedures, see paragraph 5-3.

B. SYNCHRO ALIGNMENT

(1). GENERAL

(a). This paragraph describes procedures for alignment and zeroing of synchro transmitters, receivers, differentials and control transformers individually and while operating in a system.

(b). In a general sense, "zeroing" a synchro means adjusting it mechanically so that it will work properly in a system with one or more other synchros. Specifically, "zeroing" means aligning the mechanical and electrical zero positions of a synchro. Mechanical zero of a synchro is defined as the rotor position at which the mechanical device coupled to the synchro is at its zero position. For instance, a synchro transmitter coupled to the elevation drive of an antenna is at mechanical zero when the antenna is at zero degrees elevation, and a synchro receiver driving an azimuth indicator is at mechanical zero when the indicator pointer or dial reading is zero degrees azimuth. Electrical zero of a synchro transmitter or receiver is defined as the position of the rotor when rated voltage is applied to the rotor, when there is no voltage difference between S1 and S3, and when rated voltage is applied between S2 and S1-S3 in such a way that the voltage at S2 (measured with respect to S1-S3) is in phase with the voltage at R1 (measured with respect to R2). The applied voltages and the rotor position at electrical zero are shown in figure 5-2. The voltages shown are the rated values for the synchros used in the acquisition

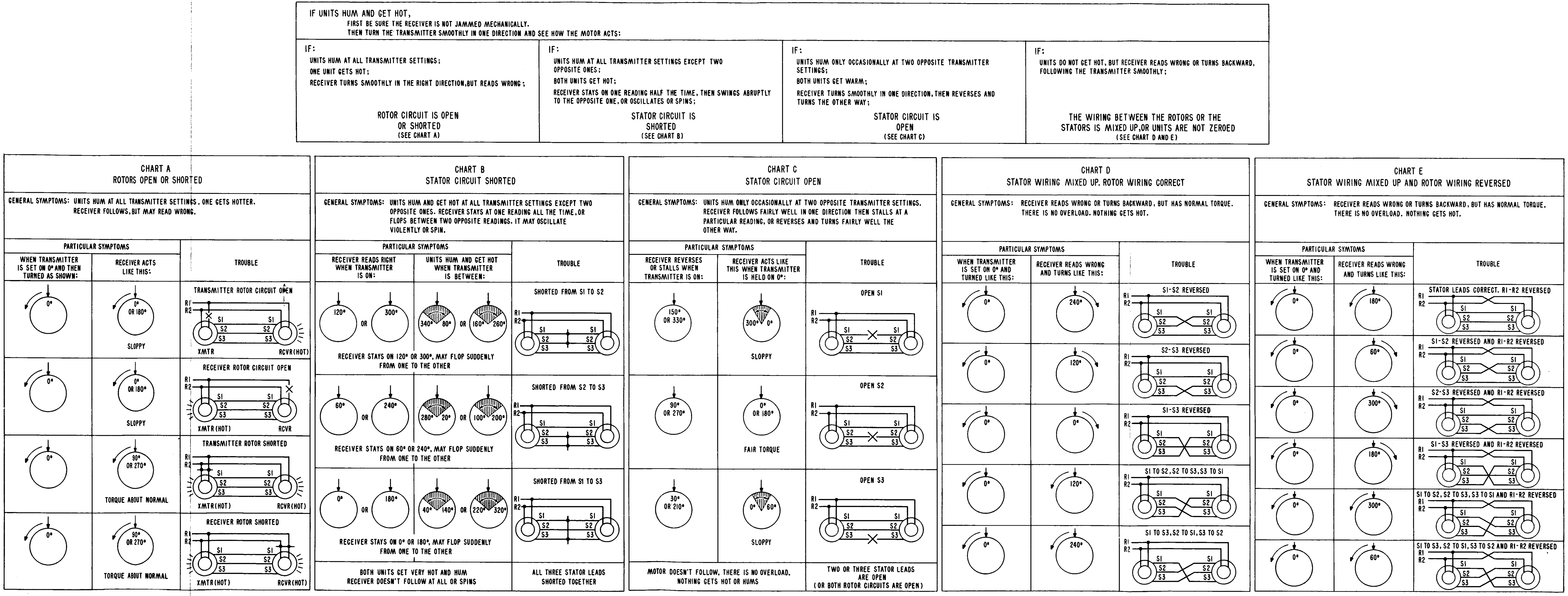


Figure 5-1. Synchro Troubles and Symptoms

system. For purposes of definition, the arrangement shown in figure 5-2 applied both to synchro transmitters and receiver, and it is actually used for zeroing receivers. However, since synchro transmitters in operating position are not free to turn, a more convenient procedure for "zeroing" is described below. The electrical zero position of a differential is as described in paragraph 4-2. D. (2). and shown in figure 4-13; the electrical zero position of a control transformer is as described in paragraph 4-2. D. (3). and shown in figure 4-15.

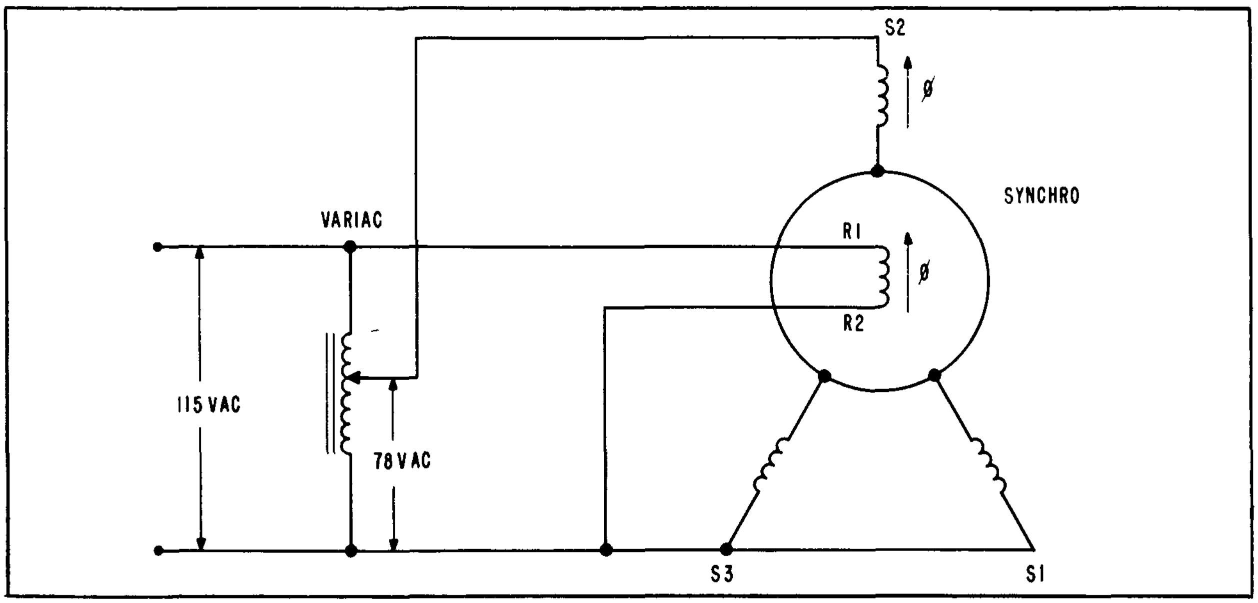


Figure 5-2. Conditions at Electrical Zero of a Synchro Transmitter or Receiver

(c). The procedures that follow comprise five sections: one each for individual zeroing of transmitters, individual zeroing of receivers, individual zeroing of differential receivers, individual zeroing of control transformers, and in-system alignment of transmitters and receivers. The first four sections apply to any individual synchro transmitter, receiver, differential receiver, or control transformer in the acquisition system.

(2). <u>SYNCHRO TRANSMITTERS</u>

The following are two procedures for zeroing synchro transmitters. The simplified procedure should be used when, but only when, the approximate electrical zero position of the transmitter is known. The reason for this restriction is that the simplified procedure is ambiguous; i.e., the null voltage, for which the synchro is adjusted in the simplified procedure, occurs at two positions, electrical zero and 180 degrees. The complete procedure allows the approximate position of electrical zero to be determined. In practice however, it is usually not necessary to follow the complete procedure. Once the transmitter has been installed and is operating properly, the transmitter can be set approximately to electrical zero simply by setting the device to which it is mechanically coupled to zero azimuth or elevation.

(a). TRANSMITTER ZEROING PROCEDURE - COMPLETE

1. Set the device to which the synchro is mechanically coupled to its zero-degree position (azimuth or elevation).

2. Turn off reference voltage to the synchro (115 VAC).

3. Disconnect the stator leads (S1, S2, S3) from the synchro.

4. Connect a jumper between synchro terminals R2 and S2 and connect a voltmeter (Hewlett-Packard 400D, 300-volt scale) between terminals R1 and S1. (See figure 5-3.)

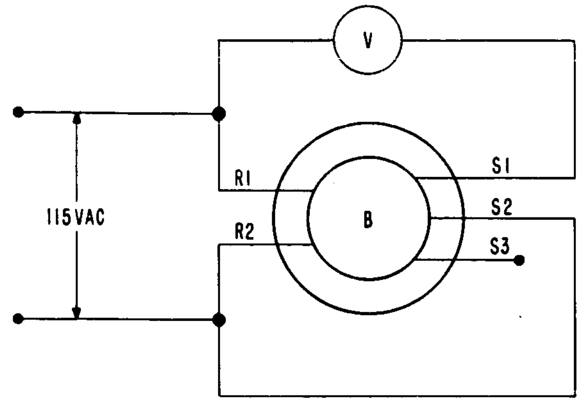
CAUTION

Before connecting the jumper between R2 and S2, make sure that the synchro has no internal jumpers which, when the external jumper is connected, would result in a short circuit of the 115 VAC power.

5. Apply 115 VAC to the rotor windings (R1 and R2) of the synchro:

a. If the meter reading is approximately 193 volts, the synchro is near electrical zero. Proceed with the simplified zeroing procedure below.

b. If the meter reading is approximately 37 volts, the synchro is near electrical 180 degrees. Turn off the 115 VAC reference, loosen the screws which hold the case, and turn the case of the synchro halfway around, so that the meter reading is approximately 193 volts. Then proceed with the simplified zeroing procedure below.



B: SYNCHRO TRANSMITTER
V: HEWLETT-PACKARD 400D AC VTVM

MAKE CONNECTIONS AND APPLY POWER AS SHOWN

APPROXIMATE METER READINGS:

NEAR ELECTRICAL ZERO POSITION - 193 VAC
NEAR ELECTRICAL 180-DEGREE POSITION - 37 VAC

Figure 5-3. Method of Locating Appropriate Position of Synchro Transmitter Electrical Zero

c. If the meter reading is something roughly midway between 37 and 193 volts, the synchro is not near either zero or 180 degrees. Proceed with the simplified zeroing procedure to set the synchro near zero or 180 degrees. Then repeat the complete zeroing procedure.

(b). TRANSMITTER ZEROING PROCEDURE — SIMPLIFIED

1. Set the device to which the synchro is mechanically coupled to its zero-degree position (azimuth or elevation).

Note

See paragraph 5-4. B. (2). for restrictions on the use of this procedure.

2. Turn off reference voltage (115 VAC) to the synchro.

3. Disconnect stator leads (S1, S2, S3) from the synchro.

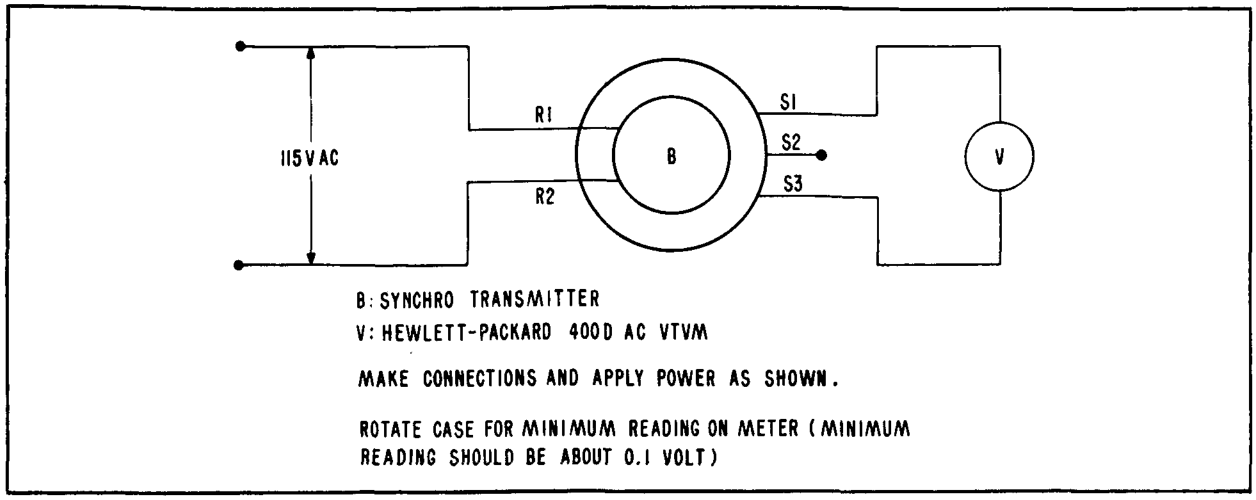


Figure 5-4. Method of Zeroing Synchro Transmitter

4. Connect a voltmeter (Hewlett-Packard 400D) between synchro terminals S1 and S3. (See figure 5-4.) To protect the meter, set it on the 100-volt scale. As lower voltage readings are obtained during the following steps of the zeroing procedure, set the meter to successively lower scales.

5. Loosen the screws which hold the case of the synchro so that the case is free to run.

6. Apply 115 VAC to the rotor windings (R1 and R2) of the synchro.

7. Turn the case of the synchro in the direction which results in a decreasing meter reading. When a very low voltage reading is obtained, rotate the case of the synchro back and forth to locate the position of null voltage on the meter. (Null voltage should be about 0.1 volt.) This position is the electrical zero of the synchro.

8. With the synchro set at electrical zero, tighten the screws which hold the case in place.

9. Turn off the reference voltage (115 VAC) and reconnect stator leads (S1, S2, S3).

(3). <u>SYNCHRO RECEIVERS—ZEROING PROCEDURE</u>

(a). Turn off reference voltage (115 VAC) to the synchro.

(b). Disconnect stator leads (S1, S2, S3) from the synchro.

(c). Connect a variac (General Radio Type W10MT) as shown in figure 5-5.

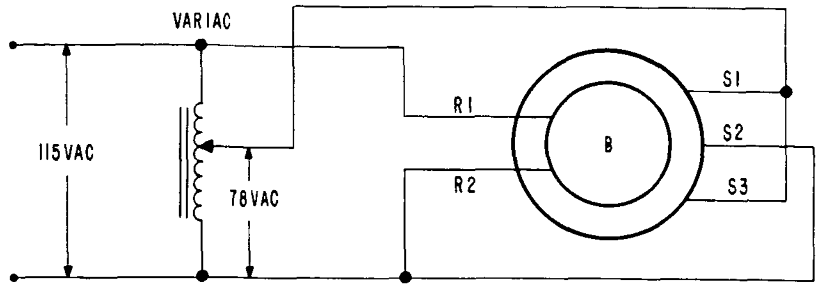


Figure 5-5. Method of Zeroing Synchro Receiver

(d). Turn on the 115 VAC reference voltage and adjust the variac for 78 VAC between synchro terminal S2 and terminals S1-S3. The synchro will turn to electrical 180 degrees.

(e). Being careful not to short circuit the 115 VAC voltage, loosen the screws which hold the case of the synchro and turn the case so that the synchro pointer or dial is at 180 degrees.

(f). Turn off the 115 VAC voltage and tighten the screws which hold the synchro case in place. The synchro is now zeroed.

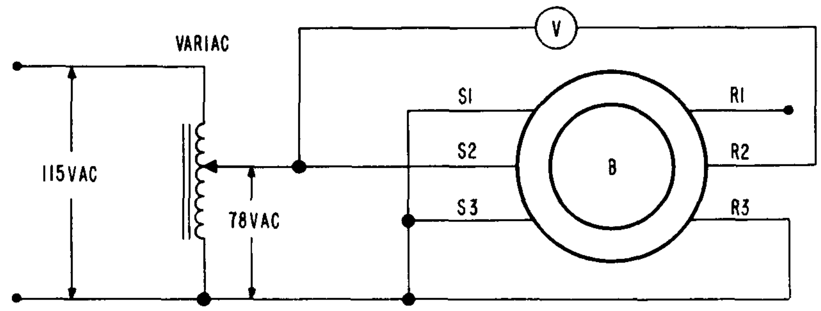
Note

The synchro receivers on the acquisition data console are so constructed that they cannot be zeroed by turning the case; the pointer must be turned on the rotor shaft. Partially disassemble the synchro and remove the pointer from the rotor shaft in accordance with the instructions in paragraph 5-4.C.

(4). <u>SYNCHRO DIFFERENTIAL RECEIVERS-ZEROING PROCEDURE</u>

(a). Disconnect the stator leads (S1, S2 and S3) and rotor leads (R1, R2 and R3) from the differential.

(b). Connect a variac (General Radio Type W10MT), voltmeter (Hewlett-Packard 400D) and jumpers to the differential as shown in figure 5-6.



VARIAC: GENERAL RADIO TYPE W10MT.
B: SYNCHRO DIFFERENTIAL RECEIVER.
V: HEWLETT-PACKARD 400D AC VTVM.

MAKE CONNECTIONS AND APPLY POWER AS SHOWN. SYNCHRO WILL TURN TO 0° OR 180°.

AT 180° METER READING WILL BE APPROXIMATELY 155 VOLTS.

AT 0° METER READING WILL BE APPROXIMATELY 28 VOLTS.

Figure 5-6. Method of Locating Approximate Position of Synchro Differential Receiver Electrical Zero

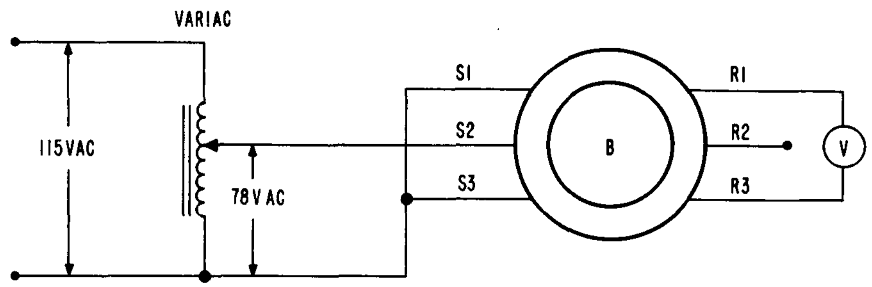
(c). Apply power and adjust the variac for 78 VAC between S2 and S1-S3. The differential will turn either to electrical zero or electrical 180 degrees, depending on which it was closer to before power was applied.

(d). If the differential turns to zero, as indicated by a meter reading of approximately 28 volts, proceed with step (e). If the differential turns to 180 degrees, as indicated by a meter reading of approximately 155 volts, remove power and reverse the position of the differential rotor (by turning the pointer 180 degrees). Again apply power. The differential should now turn to zero degrees, as indicated by a meter reading of approximately 28 volts.

Note

In order to turn the pointer, partial disassembly of the differential is necessary. Refer to paragraph 5-4.C.

(e). Without moving the pointer, and thereby turning the rotor of the differential, remove power and reconnect the variac, meter and jumpers as shown in figure 5-7.



B: SYNCHRO DIFFERENTIAL RECEIVER.
V: HEWLETT-PACKARD 400D AC VTVM.
VARIAC: GENERAL RADIO TYPE W10MT.

LOCATE APPROXIMATE POSITION OF ELECTRICAL ZERO OR 180° AND WITH POWER OFF TURN POINTER (IF NECESSARY) TO ZERO.

WITHOUT MOVING POINTER MAKE CONNECTIONS AND APPLY POWER AS SHOWN.

ROTATE POINTER ON SHAFT SO THAT ZERO POSITION COINCIDES WITH MINIMUM READING ON METER. (MINIMUM READING SHOULD BE ABOUT 0.1 VOLT.)

Figure 5-7. Method of Zeroing Synchro Differential Receiver

(f). Apply power and turn the differential rotor back and forth a few degrees (by turning the pointer) until the position which results in minimum voltage reading on the meter (about 0.1 volt) is found. This is the electrical zero position of the differential.

(g). If the pointer is not at zero degrees, remove the pointer from the rotor shaft in accordance with the instructions in paragraph 5-4.C, and replace it so that it indicates zero when the rotor is at electrical zero. The differential is now zeroed.

(5). CONTROL TRANSFORMERS

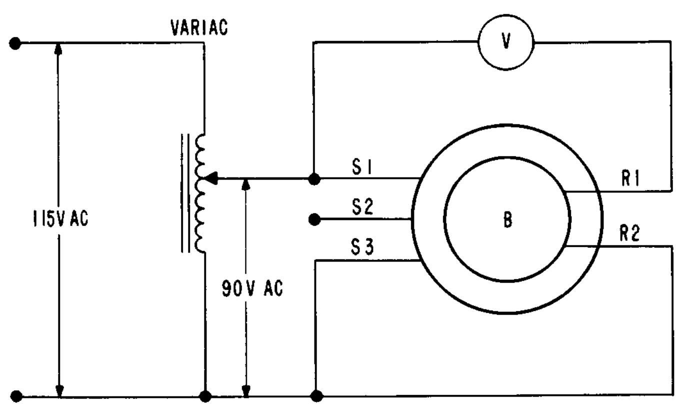
Two procedures, one complete and one simplified, for zeroing control transformers are given below. The simplified procedure should be used only when the approximate electrical zero position of the control transformer is known. Normally, the approximate electrical zero position is known, and the simplified procedure can in most cases be used.

(a). CONTROL TRANSFORMER ZEROING PROCEDURE-COMPLETE

1. Set the device to which the control transformer is mechanically coupled to its zero-degree position.

2. Disconnect the rotor (R1, R2) and stator (S1, S2, S3) leads from the control transformer.

3. Connect a jumper between terminals R2 and S3 and connect a voltmeter (Hewlett-Packard 400D, 300-volt scale) between terminals R1 and S1. (See figure 5-8.)



B: CONTROL TRANSFORMER.
V: HEWLETT-PACKARD 400D AC VTVM.
VARIAC: GENERAL RADIO TYPE W10MT.

MAKE CONNECTIONS AND APPLY POWER AS SHOWN.

ROTATE CASE FOR MINIMUM READING ON METER.
(MINIMUM READING SHOULD BE ABOUT 30 VOLTS).

Figure 5-8. Method of Locating Approximate Position of Control Transformer Electrical Zero

4. Connect a variac (General Radio Type W10MT) between terminals S1 and S3 as shown on figure 5-8 and apply 90 VAC to these terminals.

a. If the meter reading is approximately 30 volts, the control transformer is near electrical zero. Proceed with the simplified zeroing procedure below.

b. If the meter reading is approximately 120 volts, the control transformer is near electrical 180 degrees. Turn off the power, loosen the screws which hold the case, and turn the case of the control transformer halfway around. Turn the power back on; the meter reading now should be approximately 30 volts. Proceed with the simplified zeroing procedure.

(b). CONTROL TRANSFORMER ZEROING PROCEDURE-SIMPLIFIED

1. Set the device to which the control transformer is mechanically coupled to its zero-degree position.

Note

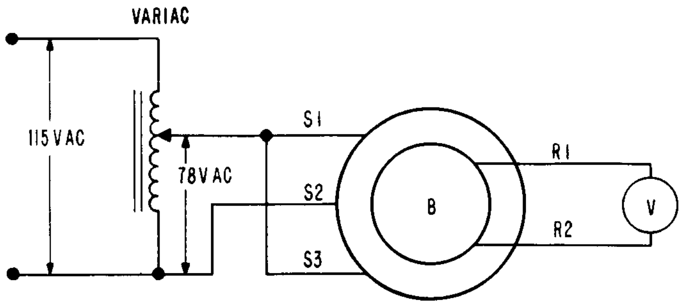
See paragraph 5-4.B.(5). for restrictions on the use of this procedure.

2. Disconnect the rotor (R1, R2) and stator (S1, S2, S3) leads from the control transformer.

3. Connect a jumper between terminals S1 and S3 and connect a voltmeter (Hewlett-Packard 400D) between terminals R1 and R2. (See figure 5-9.) To protect the meter, set it initially on the 100-volt scale. As lower voltage readings are obtained during the following steps of the procedure, set the meter to successively lower scales.

4. Loosen the screws which hold the case of the control transformer so that the case is free to turn.

5. Connect a variac between terminals S1 and S2 as shown in figure 5-9 and apply 78 VAC to these terminals.



B: CONTROL TRANSFORMER.
V: HEWLETT-PACKARD 400D AC VTVM.
VARIAC: GENERAL RADIO TYPE W10MT

MAKE CONNECTIONS AND APPLY POWER AS SHOW

ROTATE CASE FOR MINIMUM READING ON METER.
(MINIMUM READING SHOULD BE ABOUT 0.1 VOLT).

Figure 5-9. Method of Zeroing Control Transformer

6. Turn the case of the control transformer in the direction which results in a decreasing meter reading. When a very low voltage reading is obtained, rotate the case of the control transformer back and forth to locate the position of null voltage on the meter. Null voltage should be about 0.1 volt. This position is the electrical zero of the control transformer.

7. With the control transformer set at electrical zero, tighten the screws which hold the case in place.

8. Turn off power and reconnect the control transformer for normal operation in its circuit.

(6). SYSTEM ALIGNMENT

In a system consisting of a synchro transmitter and a synchro receiver or control transformer, there are three places where misalignment errors commonly arise. These three are the transmitter, the receiver, and the circuits which connect the transmitter to the receiver. When the connecting circuits consist simply of cabling, no adjustments can be made to them; errors can be corrected only at the transmitter or receiver. In a simple system consisting of a single transmitter and receiver or control transformer (a control transformer for the purposes of this discussion being equivalent to a synchro receiver), a misalignment error can be corrected by adjusting either of the two elements. In such a simple system it is immaterial where the source of error actually is; a misadjustment of the transmitter can be compensated for by adjusting the receiver to introduce an equal and opposite error. The only criterion for proper operation is that when the device which drives the synchro transmitter is pointing at a given angle, the synchro receiver indicates that angle. However, the synchros in the acquisition system are not in a simple arrangement like that just described, and although shortcut methods can and should be used as the technician becomes familiar with the configuration and characteristics of the system, the general procedure given below should be followed in most cases:

(a). When an error is noted in the synchro system, determine if possible whether the error is due to a "trouble" or a misadjustment. The criteria for making this determination are discussed in paragraph 5-3.

(b). Isolate the source of the error as much as possible. That is, where there is more than one receiver connected to a transmitter, check all of the receivers to see whether the error shows up on all or on only one. (See figures 5-10 and 5-11.)

(c). Individually check the adjustment of each of the units (transmitter, receiver, differential, control transformer) for possible source of the particular error. Careful adjustment of the individual units should correct the majority of system errors. Individual check and adjustment procedures for synchro transmitters, receivers, differentials and control transformers are given in paragraphs 5-4.B.(2)., (3)., (4)., and (5).

(d). When individual adjustment of the units of the system does not correct the error, system alignment should be made as follows:

1. Do not change the synchro transmitter i.e., leave this unit as it was set in accordance with the individual adjustment procedure.

2. Set the device mechanically coupled to the transmitter to a known position (azimuth or elevation).

3. For synchro receivers, loosen the screws which hold the case and with the synchros energized (115 VAC applied) turn

the case so that the receiver indication is the same as the position of the antenna.

Note

The case of the synchro receivers on the acquisition data consoles cannot be turned; the pointer must be turned on the rotor shaft. Refer to the note in paragraph 5-4.B.(3).(a).

4. For the differentials, turn the pointer on the rotor shaft so that the pointer indicates the angular sum of the ship's heading and the relative azimuth of the antenna with which the differential is associated. The sum of these two angles is the true azimuth of the antenna.

5. Before adjusting a control transformer to compensate for errors introduced by interconnecting cabling, be sure that changing the setting of the control transformer will not introduce an error into the positioning system with which the control transformer is associated.

C. SYNCHRO REPAIR

(1). REPAIR PROCEDURES

(a). It is recommended that major repairs on synchro devices (transmitters, receivers, differentials, and control transformers) not be attempted in the field. However, minor repairs such as replacing broken pointers or dial plates and repairing broken connections (where wiring is accessible) can be made. For information on replacement of defective parts or gaining access to internal wiring of synchros on the acquisition data console, refer to the disassembly and assembly procedures below. For information on other synchros in the acquisition system, refer to the applicable equipment manuals.

(b). When there is a question as to whether a synchro is defective and requires replacement, the winding resistances should be checked. For the synchro receivers on the acquisition data consoles the d-c

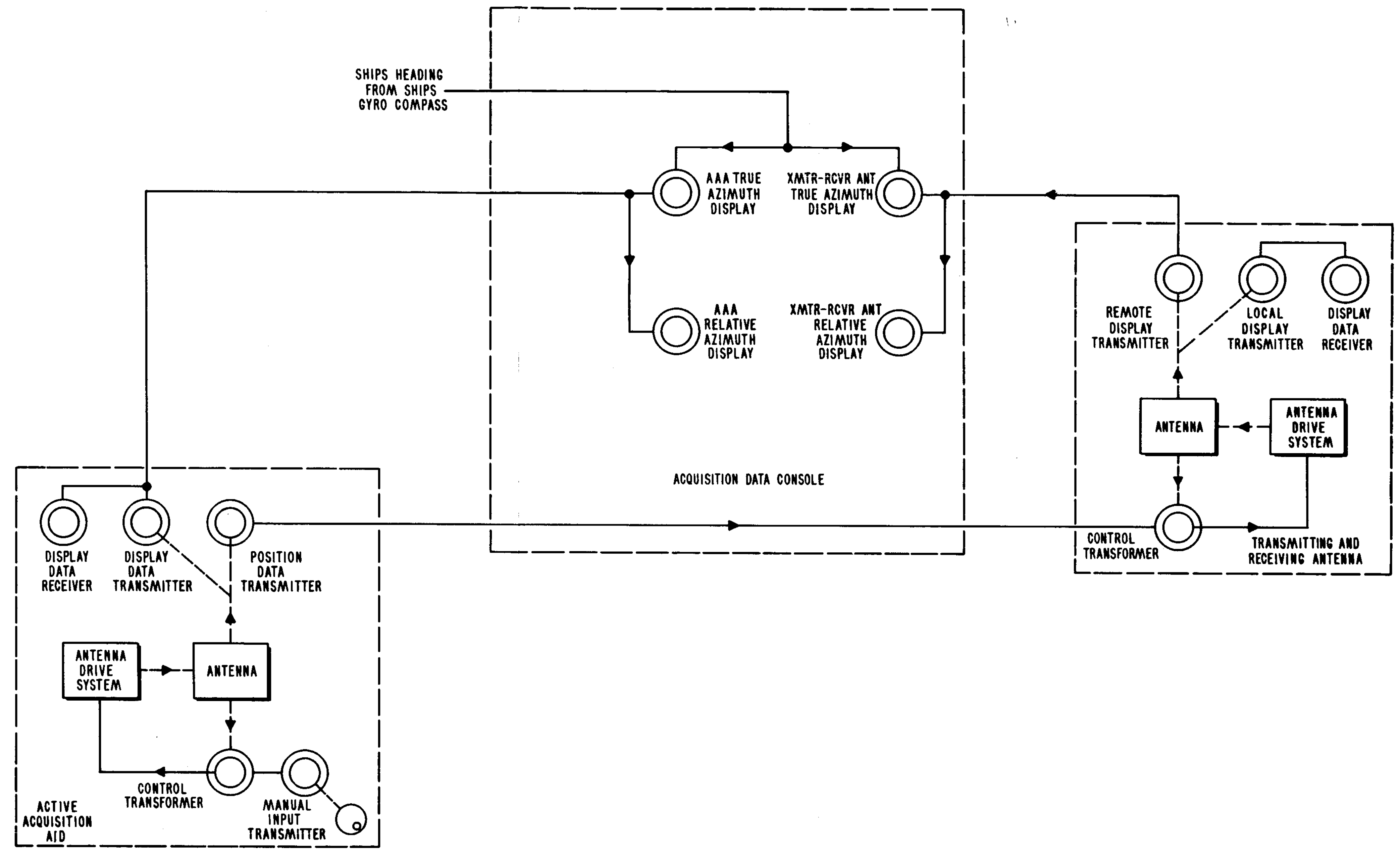


Figure 5-10. Azimuth Synchro System, Schematic Diagram

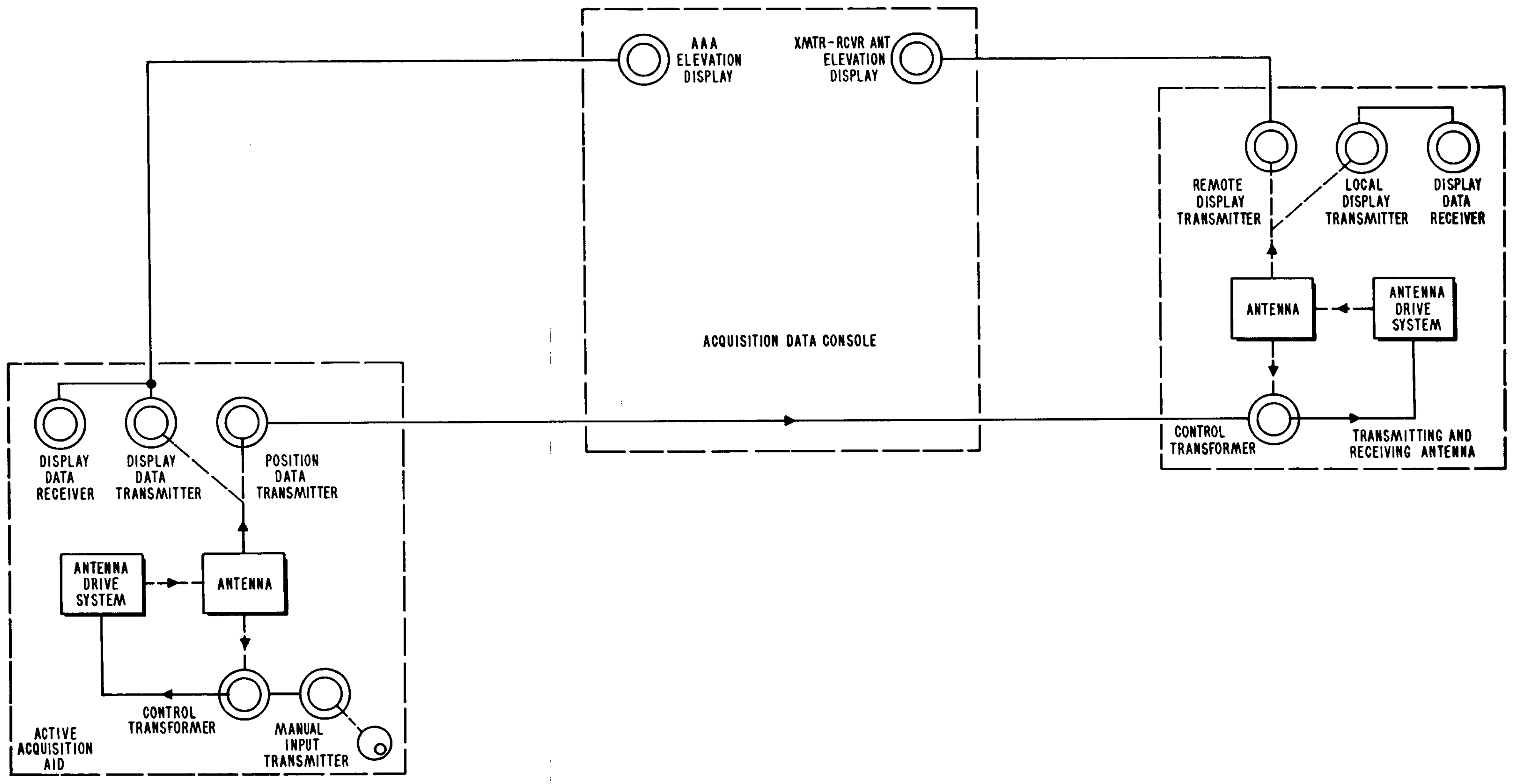


Figure 5-11. Elevation Synchro System, Schematic Diagram

resistance of the stator windings (S1-S2, S2-S3, and S1-S3) should be about 95 ohms at room temperature, and the d-c resistance of the rotor winding (R1-R2) should be about 85 ohms, at room temperature. For synchros in other equipment, comparable d-c resistance measurements should be obtained. For the differential receivers, or when a resistance measurement of some other synchro is doubtful, compare the resistances of corresponding windings in two identical synchros, or two windings of the same synchro. (The two differentials on the acquisition data console are identical.)

(2). DISASSEMBLY

The disassembly procedure described in this paragraph applies to the synchro receivers and differentials on the acquisition data console. See figure 5-12.

(a). Dismount the synchro receiver or differential from the panel by removing the four mounting screws and nuts.

(b). Remove the eight screws which hold the bezel onto the front housing. Remove the bezel, dial plate and gasket and set them aside.

(c). Pull or pry the pointer off the end of the rotor shaft. As shipped from the factory, the pointer is secured to the shaft with a drop of glue, and considerable force may be necessary to remove it. However, care should be exercised not to damage the fragile pointer during removal.

(d). Pull out the retaining ring and remove the dial.

(e). Remove the four screws which hold the front and rear housings together. Remove the front housing and "0" ring. With the front housing removed, only the wires from the connector to the synchro itself hold the synchro in the rear housing. Do not hold the rear housing in such a position that the connecting wires support the weight of the synchro.

(f). Remove the four screws which fasten the connector to the rear housing.

(g). Pull the connector as far away from the rear housing as the wiring permits and unsolder the wires from the connector pins. Drop

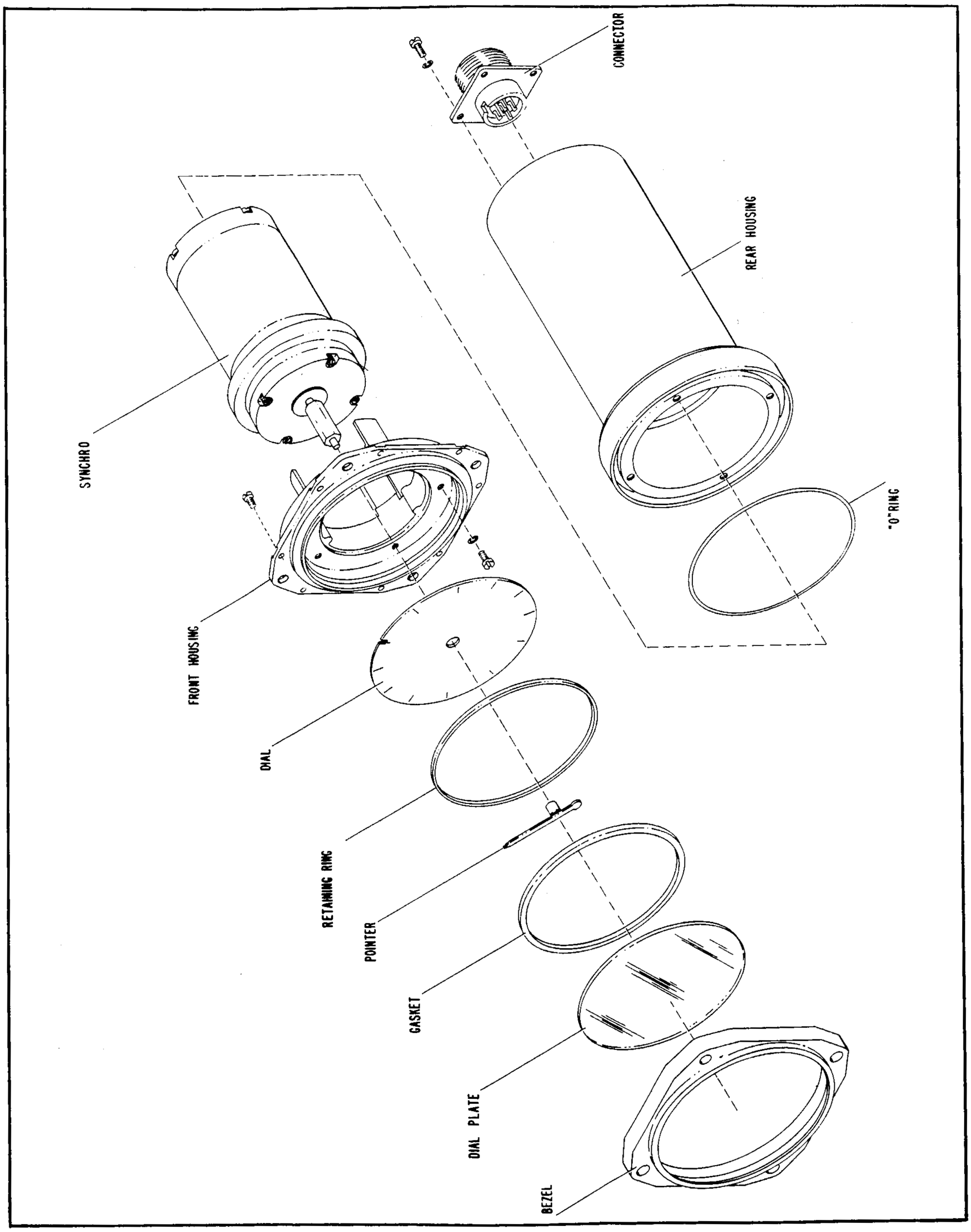


Figure 5-12. Acquisition Data Console Synchro Receiver or Differential Receiver, Exploded View

the synchro itself out of the rear housing. This is as far as field disassembly should proceed.

(3). ASSEMBLY

Assembly of the synchro receivers and differentials on the acquisition data consoles is the reverse of the disassembly procedure, except that particular attention should be paid to the pointer. Be sure that the pointer is replaced at the proper angle on the rotor shaft (refer to paragraph 5-4.B.), and if necessary crimp the pointer socket slightly to obtain a secure fit on the rotor shaft.

D. 28 VDC POWER SUPPLY

The acquisition data console 28 VDC power supply comprises two principal parts; one is the control circuits, and the other is the dual power supply. The control circuits consist of relays and diodes, on the relay chassis, and the switch assemblies (with indicators), on the acquisition data panel. The dual power supply consists of a front panel (with a switch, fuses, and a power-on indicating lamp) and power supplies number 1 and 2, each consisting of a power supply unit and a filter unit. This paragraph describes adjustment and repair procedures for the control circuits and for the dual power supply. Since it is unlikely that a single trouble in the console will affect both power supplies number 1 and number 2 and their associated control circuit, the repair procedures are based on the assumption that only one power supply and/or its associated control circuits is malfunctioning. If neither power supply is operative, check switch S6201 on the dual power supply and check the primary power, 115 VAC, to the console.

(1). CONTROL CIRCUITS

The following procedure is applicable specifically for checking and isolating trouble in the control circuits associated with power supply number 1. With appropriate substitutions in the reference designations of components, terminals, etc., the same procedure is applicable to the control circuits associated with power supply number 2.

(a). With switch S6201 on the dual power supply in the off position, connect a temporary jumper around blocking diode CR6001. The purpose of the jumper is to connect 28 VDC from power supply number 2 to the control circuits of power supply number 1.

(b). Remove plug P6201 from jack J6201 on the dual power supply.

(c). Turn on switch S6201 on the dual power supply, and depress switch S6002 on the acquisition data panel. Power supply number 2 is energized and 28 VDC is applied to the control circuits of power supply number 1. If the power supply number 1 control circuits are functioning properly, the green indicator lamps in switch S6001 on the acquisition data panel will be lit, and the switch when depressed will stay depressed, connecting 115 VAC to pins A and B of plug P6201 (measure with a voltmeter). Failure to perform as described indicates that the trouble is in the control circuits; proceed as follows to isolate the trouble.

(d). With a voltmeter measure the voltage across zener diode CR6003. It should be 18±1 VDC; if it is not, the diode is defective.

(e). Check the coil and contacts of relay K6001. The coil should have a d-c resistance of 1000 ohms. The contacts can conveniently be checked by measuring the voltage drop across each pair that should be closed; there should of course be no voltage across closed contacts.

(f). Check the coil, contacts, and indicator lamps in switch S6001. The coil should have a d-c resistance of 480 ohms. Check the contacts for voltage drop across each pair that should be closed.

(2). DUAL POWER SUPPLY

(a). ADJUSTMENT

The individual power supplies in the dual power supply should be adjusted so that at the maximum normal load imposed by the console and with the prevailing a-c line voltage input to the console, the output of each power supply onto the console 28 VDC bus is as close as possible to 25 VDC. With a given a-c line voltage, a d-c output voltage within the range of 24 to 26 VDC normally should be obtainable. If only the extremes of this range can be obtained, the output voltage should be set at the higher end of the range. Also, the power supplies should be adjusted so that with extremes of line voltage fluctuation and with d-c load variations from minimum to maximum, the d-c voltage output of the dual power supply is in no case greater than 30 VDC or less than 22.5 VDC. Voltages greater than 30 VDC are likely to overheat and thus damage the color filters in the console indicators, and any voltage less than 22.5 VDC may not be sufficient to operate the power supply control circuits. The curves of figures 5-13 and 5-14 are provided for reference in case it is necessary to adjust the power supplies with an a-c line voltage other than the prevailing one or with loads which differ appreciably from the normal maximum. The curves of figure 5-13 include the effects of the power supply control circuits and therefore apply when the dual power supply is in the console and voltages are measured on the console 28 VDC bus. The curves of figure 5-14 apply when the control circuits are disconnected and voltages are measured right at the output of a filter unit (terminal board TB6203 or TB6204 terminals 3 and 2), as when the dual power supply is on the bench. For an a-c line voltage near 115 VAC, transformer secondary connections to terminal board terminals 2 and 4 should provide the proper d-c output voltage. (The maximum normal load is approximately one ampere.) For other a-c line voltages, the curves of figures 5-13 and 5-14 show the transformer secondary connections which should produce the correct output voltage. Proceed as follows to check and adjust the power supply output voltages when the dual power supply is connected to the console for normal operation. The procedure for checking and adjusting when the dual power supply is on the bench is essentially the same as the following, but the details of the on-the-bench procedure will depend on the particular test setup used:

1. Energize power supply number 1 by turning on switch S6201 on the dual power supply and depressing "28V SUPPLY" switch S6001.

2. Apply maximum normal load to the power supply by energizing as many switches, indicators and relays as can be energized at one time.

3. Measure the voltage output of power supply number 1 between terminals 3 and 4 of terminal board TB6001 or any other

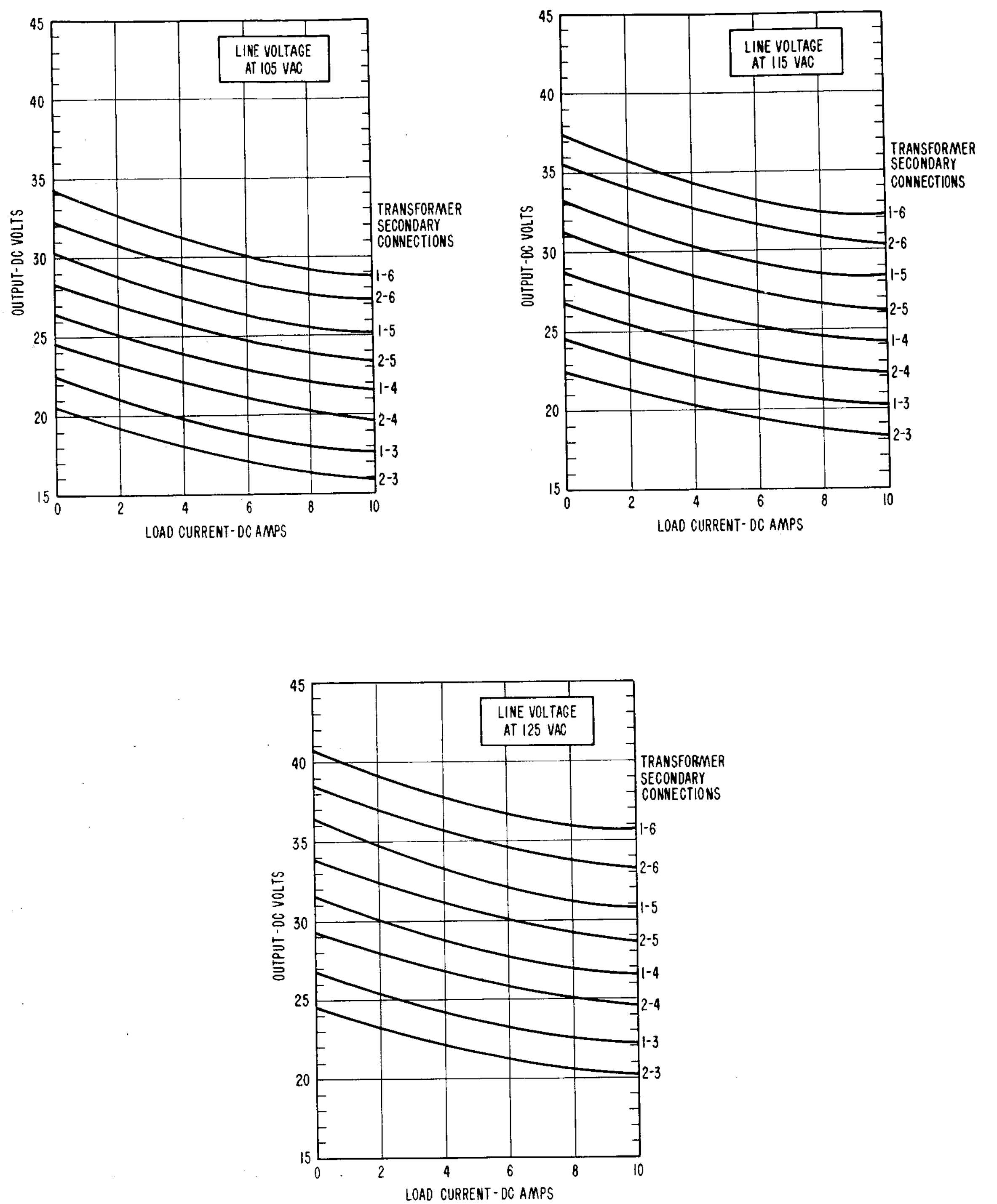


Figure 5-13. Power Supply and Control Circuit Output Voltage versus Load Current Characteristics

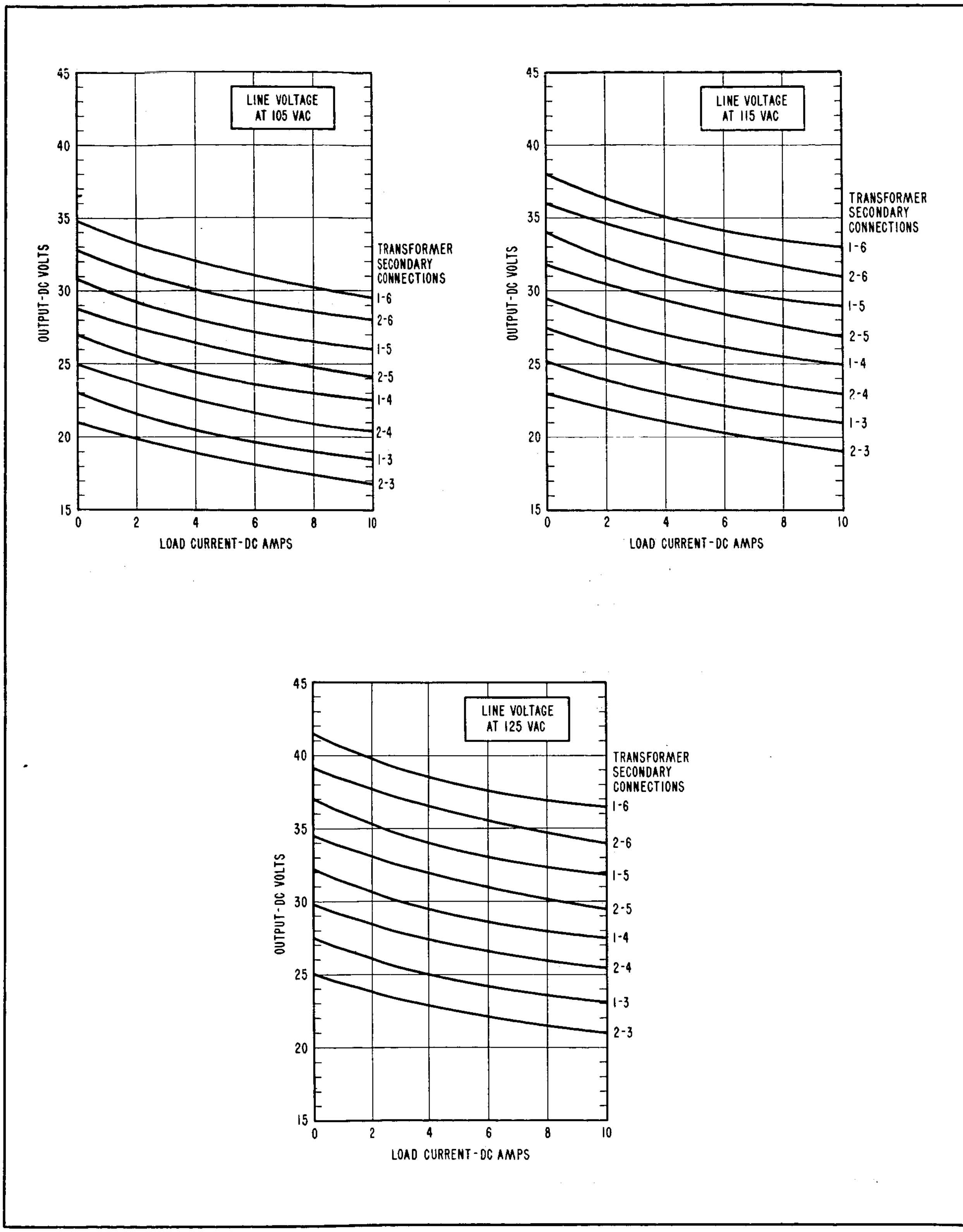


Figure 5-14. Power Supply Output Voltage versus Load Current Characteristics with Control Circuit Disconnected

convenient place on the console 28 VDC bus. (See figure 7-1.)

4. The output voltage of the power supply should be as described above (24 to 26 volts with the prevailing a-c line voltage supplied to the console). If it is not, adjust the voltage by changing on terminal board TB6201 the connections to the secondary taps of transformer T6201. By changing these connections, the d-c output voltage of the power supply can be adjusted over a range of about 14 volts in steps of approximately two volts. Moving one connecting wire between TB6201 terminals 3 and 4, 4 and 5, or 5 and 6 increases or decreases the d-c output by about four volts; and moving the other connecting wire between TB6201 terminals 1 and 2 increases or decreases the output voltage by about two volts. (See figure 5-15.)

5. Turn off power supply number 1 and repeat steps one through four with appropriate changes in reference designations for power supply number 2.

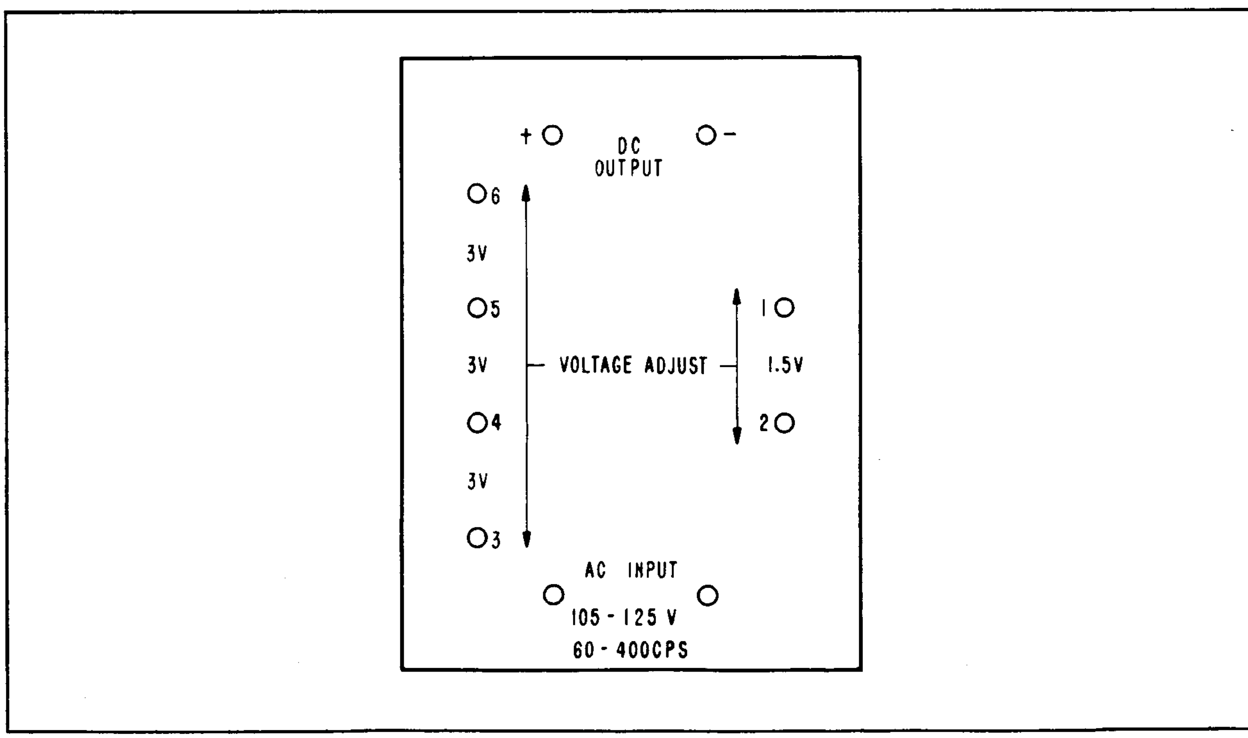


Figure 5-15. Power Supply Unit Terminal Board

(b). REPAIR

Correction of a malfunction in the dual power supply can be affected by conventional trouble shooting and repair procedures. Check a-c and d-c voltages and check continuity of power transformer T6201 or T6202 and filter choke L6201 or L6202. See the dual power supply schematic and physical wiring diagrams, figures 7-3 and 7-4. For location of parts on the power supply units and filter units, see figure 5-16.

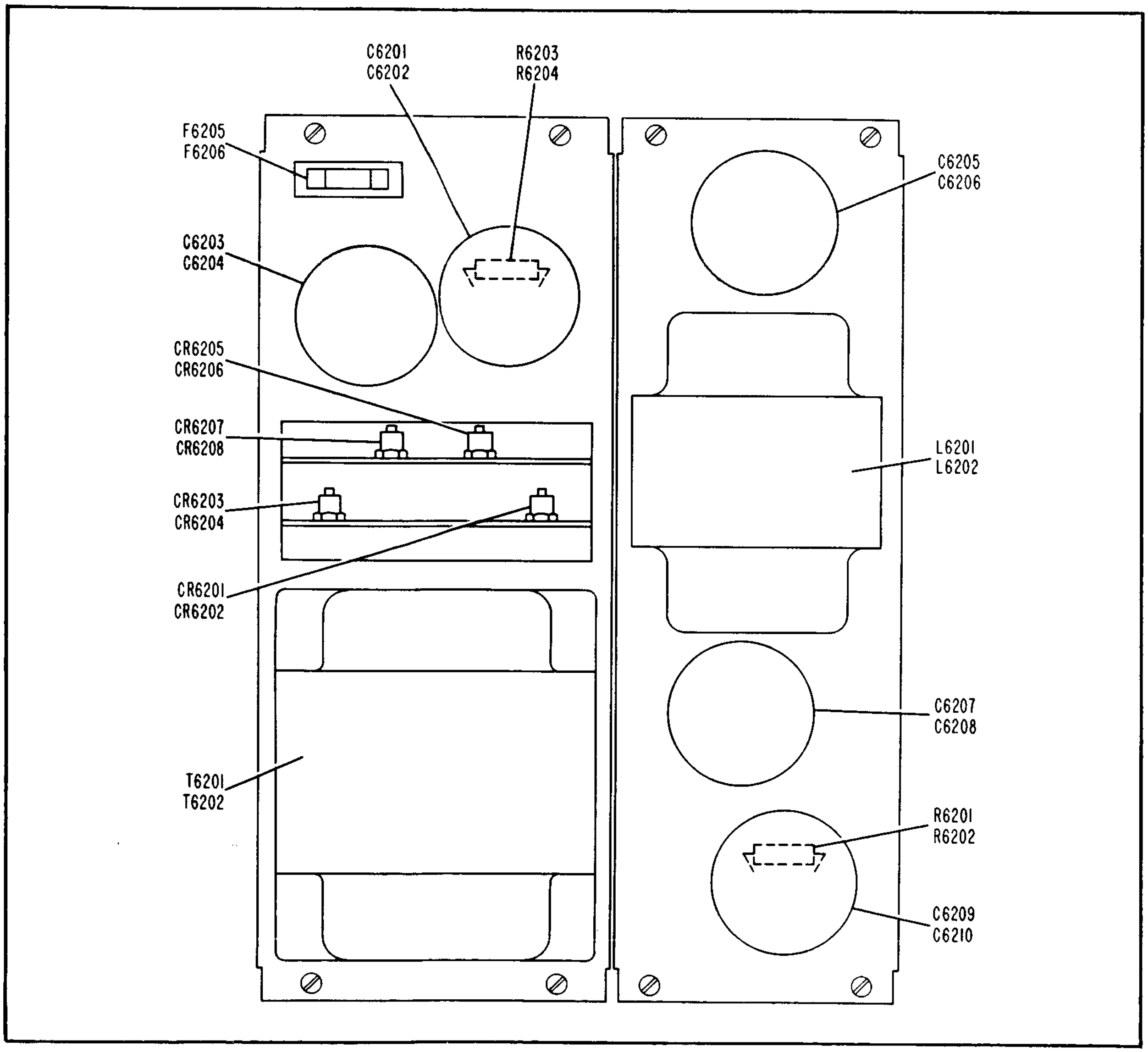


Figure 5-16. Power Supply Unit and Filter Unit, Parts Location

Normal a-c voltages for the power transformers are shown in table 5-II. Bear in mind that two switches are in series with the primary 115 VAC power to each power supply in the dual power supply: for power supply number 1 these switches are S6201 on the dual power supply and S6001 on the acquisition data panel; for power supply number 2 the switches are S6201 on the dual power supply and S6002 on the acquisition data panel. Bear in mind also that in addition to the fuses, F6201-F6204, on the front panel of the dual power supply, there is another fuse (F6205, F6206) on each of the power supply units (PD6201 and PS6202).

TABLE 5-II. NORMAL POWER TRANSFORMER VOLTAGES (T6201, T6202)

Terminal Board TB6201 or TB6202 Pins	Approximate RMS Voltage
1-6	28
2-3	18
1-2	1.5
3-4	3
4-5	3
5-6	3
7-8	115

E. RELAYS

(1). Both of the relays used on the acquisition data consoles are hermetically sealed, and no maintenance or repair is possible. When one of them becomes defective, replace it. To ascertain that a console relay is defective, check the following:

(a). Coil resistance: D-c coil resistance should be as follows:

K6001, K6002: 1000 ohms.

(b). Contacts: With all power off, check continuity between normally-closed contacts. With the suspected relay energized and voltage applied across the contacts, check for voltage drop across normally-open contacts. There should of course be none.

(2). For detailed information on relays in the acquisition system outside the acquisition data console, see the applicable equipment manuals.

F. SWITCH AND INDICATOR ASSEMBLIES

For a description of acquisition data console switch and indicator assemblies and how they work, refer to paragraph 4-2. B. (3). and figure 4-3.

(1). INDICATORS AND OPERATOR-INDICATOR UNITS

Maintenance of indicators and the operator-indicator unit portion of switch assemblies consists simply of replacing loose or defective lamps and color filters. Replacement of these items is most easily accomplished with the use of the special lamp-filter tool, figure 5-17 (Microswitch part number 15PA19).

(2). COILS

The coil portion of switch assemblies can best be checked by observing the action of the plunger. When the plunger is depressed and the coil energized, the plunger should remain securely in the depressed, or actuated, position. Also check the d-c resistance of the coil. It should be about 480 ohms.

(3). SWITCHES

The operation of the switch portion of switch assemblies can be c checked by seeing whether all of its contacts make and break properly as the coil plunger is depressed and released. Faulty or intermittently faulty operation of a switch section can often be corrected by adjusting the amount of bend in the small arm which actuates the individual switch section plunger (as distinguished from the main, or coil plunger). When the operation of a switch section is faulty and cannot be corrected, the entire switch portion of the switch assembly must be replace.

G. SIGNAL STRENGTH METER CALIBRATION

To calibrate each of the signal strength meters on the acquisition data console, proceed as follows:

(1). Connect an r-f signal generator to the telemetry receiver with which the meter to be calibrated is associated. (Refer to the Telemetering System Manual, MS-106, for further information on the signal generator and telemetry receiver.)

(2). With the telemetry receiver in operating condition and the signal generator frequency set at the operating frequency of the receiver, adjust the signal generator output level to 100 microvolts.

(3). Adjust signal strength meter CALIBRATION CONTROL R6001, R6002, R6003, or R6004 (figure 3-1) until the meter with which it is associated indicates 100 microvolts.

5-5. LUBRICATION

Table 5-III is a lubrication schedule for all of the equipment in the acquisition system.

5-6. SPECIAL TOOLS

The only special tool required for maintenance of the acquisition system is the lamp-filter tool (Microswitch part number 15PA19, Bendix Radio part number A683836-1). This tool, shown in figure 5-17, is used for removal and replacement of the lamps and color filters in the indicators and switch assemblies on the acquisition data console.

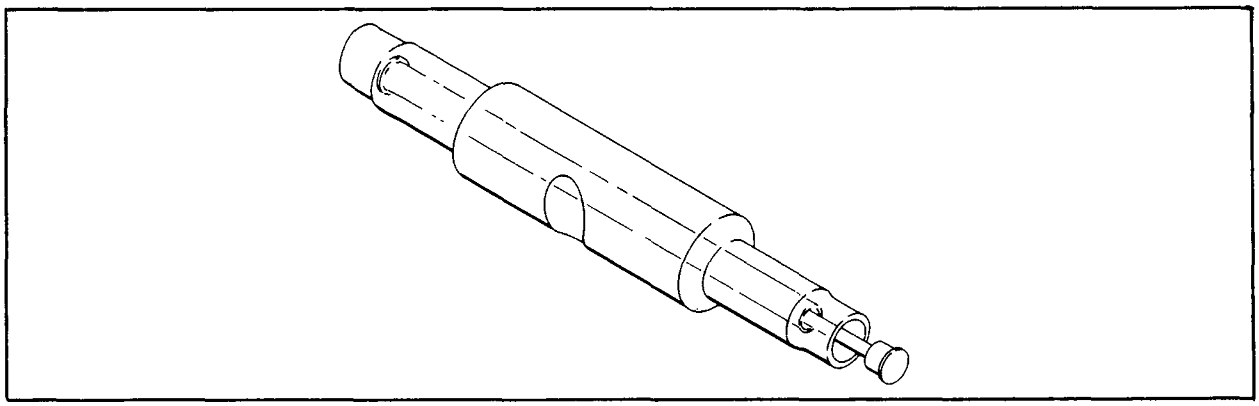


Figure 5-17. Lamp-Filter Tool

5-7. TEST EQUIPMENT

Each piece of test equipment required for maintenance of the acquisition system is listed in table 5-IV along with a brief description of its application.

TABLE 5-III. LUBRICATION SCHEDULE

Lubrication Point	Procedure	Lubricant	Frequency
ACQUISITION DATA CONSOLE			
No lubrication required.	-	-	-
ACTIVE ACQUISITION AID			
Elevation Drive Assembly	Add oil as needed. Refer to equipment manual.	High grade SAE 10 nondetergent lubricating oil.	Monthly
Azimuth Drive Assembly	Drain water from sump and add oil as needed. Refer to equipment manual.	High grade SAE 10 nondetergent lubricating oil.	Weekly
Antenna Control Unit	Clean and re-lubricate gears. Refer to equipment manual.	High grade SAE 10 nondetergent lubricating oil and lubriplate	As required.
Muffin fans in RF Housing	Lubricate with one or two drops of oil. Refer to equipment manual.	Aero Shell No. 12 (MIL-L-6085)	Monthly

TABLE 5-IV. TEST EQUIPMENT APPLICATIONS

Equipment	Manufacturer	Model	Application
Oscilloscope	Hewlett-Packard Company	130B	General waveform observation and voltage measurements.
Oscilloscope	Tektronix, Incorporated	545A	General waveform observation and voltage measurements.
Dual-Trace Calibrated Preamplifier	Tektronix, Incorporated	Type CA	Oscilloscope plug-in unit used with Tektronix 545A.
Plug-In Preamplifier	Tektronix, Incorporated	Type L	Oscilloscope plug-in unit used with Tektronix 545A.
Viewing Hood	Tektronix, Incorporated	H510	Aid in viewing of oscilloscope screens.
Oscilloscope Cart	Technibilt Corporation	OC-2 (Bendix Radio Part - A683940-2)	Support and transportation of oscil-loscopes.
Oscilloscope Cart	Technibilt Corporation	OC-2 (Bendix Radio Part-A683940-1)	Support and transportation of oscil-loscopes and storage of plug-in units.
Unit Regulated Power Supply	General Radio Company	1201-B	General bench testing of assemblies. Provides a source of a-c heater voltage at 6.3 VAC and 4A, and d-c plate power at 300 VDC and 70 MA.
Regulated Power Supply	Lambda Electronics Corporation	71	General purpose power supply with following outputs: 0-500 VDC, 0-200 MA; 0-200 VDC, 0-50 VDC, Bias; and 6.5 VAC, 5A.
DC Power Supply	John Fluke Manufacturing Company, Incorporated	407	High resolution power supply with output of 0 to 555 volts and 0 to 300 MA for calibration purposes.
Square Wave Generator	Tektronix, Incorporated	Type 105	Alignment and testing of oscilloscopes and associated plug-in units.

TABLE 5-IV. TEST EQUIPMENT APPLICATIONS (Cont.)

Equipment	Manufacturer	Model	Application
Signal Generator	Boonton Radio Corporation	225-A	Test and alignment of receivers, sensitivity and bandwidth measurements in the 10- to 500-MC frequency range.
Sweep Generator	Telonic Industries, Incorporated	HN-3	Testing and adjusting r-f circuits in the frequency range of 0.5 to 300 MC.
HF Signal Generator	Hewlett-Packard Company	606-A	General purpose signal generator with a frequency range of 50 KC to 65 MC.
Function Generator	Hewlett-Packard Company	202-A	Test and adjustment of circuits which handle non-sinusoidal waveshapes.
Transfer Oscillator	Hewlett-Packard Company	540-B	Test and alignment of signal generators up to 2000 MC.
Wide Range Oscillator	Hewlett-Packard Company	200 CD	Test and adjustment of circuits in the range of 5 CPS to 600 KC.
Unit Oscillator	General Radio Company	1209-BL	Test and alignment of receivers, sensitivity and bandwidth measurements in the 180- to 600-MC range.
Universal EPUT and Timer	Beckman Instruments, Inc.	7370	Precision frequency measurements from 10 CPS to 11.5 MC.
Frequency Converter	Beckman Instruments, Inc.	7570 through 7573	Used with Beckman EPUT and timer to measure frequencies up to 220 MC.
Field Strength Meter	Empire Devices Products Corporation	NF-105 (Bendix Part No. A683351)	Noise figure measurements in the 150-KC to 400-MC frequency range.

TABLE 5-IV. TEST EQUIPMENT APPLICATIONS (Cont.)

Equipment	Manufacturer	Model	Application
Power Output Meter	The Daven Company	OP-962	Audio frequency power measurements in the power range of 0.1 milliwatt to 100 watts.
Potentiometric DC Voltmeter	John Fluke Manufacturing Company, Incorporated	801	Precision d-c measurements with .05 per cent accuracy over the range of .01 to 500 volts.
Vacuum Tube Voltmeter	Hewlett-Packard Company	410B	General a-c, d-c, and r-f voltage measurements and resistance measurements.
Vacuum Tube Voltmeter	Hewlett-Packard Company	400D	Accurate a-c voltage measurements from .001 volt to 300 volts over a frequency range of 10 cycles to 4 megacycles.
Volt-Ohm-Milliammeter	Triplett-Electrical Instrument Company	630-PL	General voltage, current and resistance measurements, (20,000 ohm/volt).
Noise and Distortion Analyzer	Hewlett-Packard Company	330B	Measure total distortion of any frequency from 20 to 20,000 CPS.
RF Detector	Telonic Industries, Incorporated	XD-3	Detect output of r-f preamplifiers and i-f amplifiers in the 0.5- to 1000-MC range.
Tube Analyzer	Triplett Electrical Instrument Company	3444	Tube checks.
Variac	General Radio Company	W10MT	General purpose voltage source with output of 0-115 VAC at 10 amps.
Attenuator Pad	Telonic Industries, Inc.	TGC-50	Matching, isolation and general bench test applications in the 0.5- to 1000-MC frequency range.
Miscellaneous Cables and Accessories	-	-	-

SECTION VI
PARTS LIST

6-1. GENERAL

This section comprises lists of the parts which make up the acquisition data console. The lists are as follows:

Equipment	Parts List Table	Parts Location Illustrations
Acquisition Data Console P/N R651499-3	6-I	Figure 7-2
Dual Power Supply, P/N R651470-2	6-II	Figures 5-16 and 7-4
Intercom Panel, P/N N654990-6	6-III	—
Miscellaneous Items	6-IV	—

6-2. OTHER EQUIPMENT

For information on other equipment in the acquisition system, refer to the applicable equipment manuals, listed in table 1-II.

TABLE 6-I. LIST OF REPLACEABLE ELECTRICAL PARTS FOR ACQUISITION DATA CONSOLE, P/NR651499-3

Reference Designation	Part Name and Description	Bendix Part No.	Part No. (MIL, JAN, or FSN)	Quan.
B6001 and B6002	Synchro Differential Receiver	N681819-4	—	2
B6003 and B6004	Synchro Receiver	N681819-2	—	2
B6005 and B6006	Synchro Receiver	N681819-3	—	2
CR6001 and CR6002	Diode, Silicon	A683966-1	—	2
CR6003 and CR6004	Diode, Zener	A683971-1	—	2
DS6001 through DS6008	Lamps, Dialco No. 39	A683817-3	—	8
DS6009 and DS6010	Not Used	—	—	
DS6011 through DS6022	Lamp, GE 327	—	AN3140-327	12
K6001 and K6002	Relay, Sensitive, 1000 ohms, 4.5 ma, DPDT	A683969-3	—	2

TABLE 6-I. LIST OF REPLACEABLE ELECTRICAL PARTS FOR ACQUISITION DATA CONSOLE, P/N R651499-3 (Cont.)

Reference Designation	Part Name and Description	Bendix Part No.	Part No. (MIL, JAN, or FSN)	Quan.
M6001 through M6004	Meter, 0-50 uamp	N683770-1	—	4
P6001 and P6002	Connector	—	MS3106A-14S-6S	2
P6003 through P6006	Connector	—	MS3106A-14S-2S	4
R6001 through R6004 (Indian Ocean Ship)	Potentiometer, 500K	C219564-6	—	4
R6001 (Atlantic Ship)	Potentiometer, 500K	C219564-6	—	1
R6002,R6003 (Atlantic Ship)	Potentiometer, 1 meg.	C219564-15	—	2
R6004 (Atlantic Ship)	Potentiometer, 500K	C219564-6	—	1
R6005 through R6008 (Indian Ocean Ship)	Resistor, 240K, 1/4W, ±5%	—	RC07GF244J	4

TABLE 6-I. LIST OF REPLACEABLE ELECTRICAL PARTS FOR ACQUISITION DATA CONSOLE, P/N R651499-3 (Cont.)

Reference Designation	Part Name and Description	Bendix Part No.	Part No. (MIL, JAN, or FSN)	Quan.
R6005 through R6008 (Atlantic Ship)	Resistor, 220K, 1/4w, 5%	—	RC07GF224J	4
S6001	Switch Assembly, consisting of:			
	Switch, 3PDT Momentary	A681845-4	—	1
	Operator Indicator Unit w/Coil	A681843-3	—	1
	Display Screen	A681848-2	—	1
	Color Filter (Red)	A683911-1	—	2
	Color Filter (Green)	A683911-3	—	2
	Lamps, DS6011, DS6012, DS6013, DS6014	—	—	4
S6002	Switch Assembly, consisting of:			
	Switch, 3PDT, Momentary	A681845-4	—	1
	Operator Indicator Unit w/Coil	A681843-3	—	1
	Display Screen	A681848-2	—	1
	Color Filter (Red)	A683911-1	—	2
	Color Filter (Green)	A683911-3	—	2
	Lamps, DS6015, DS6016, DS6017, DS6018	N683874-5	—	4
TB6001	Terminal Board	L678289-8	—	1
TB6002 through TB6017	Terminal Board	L678288-8	—	16
X6002	Indicator Unit, consisting of:	A683961-2	—	1
	Display Screen	A681848-4	—	1
	Color Filter (Red)	A683911-1	—	2
	Color Filter (Green)	A683911-3	—	2
	Lamps, DS6019, DS6020, DS6021, DS6022	N683874-6	—	4

TABLE 6-I. LIST OF REPLACEABLE ELECTRICAL PARTS FOR ACQUISITION DATA CONSOLE, P/N R651499-3 (Cont.)

Reference Designation	Part Name and Description	Bendix Part No.	Part No. (MIL, JAN, or FSN)	Quan.
XDS6001 through XDS6008	Pilot Light Assembly	A683815-1	—	8
P6201	Connector	—	MS3106E-18-12S	1
P6202	Connector	—	MS3106E-20-7S	1
	Intercom Panel	R654990-6	—	1
	Dual Power Supply	R651470-2	—	1
	Telephone Jacks, WECO, P/N 238A	A683777-1	—	10
	Barrier Strips (used with indicator units and switch assemblies)	A681860-2	—	6

TABLE 6-II. LIST OF REPLACEABLE ELECTRICAL PARTS FOR DUAL POWER SUPPLY, P/N R651470-2

Reference Designation	Part Name and Description	Bendix Part No.	Part No. (MIL, JAN, or FSN)	Quan.
DS6201	Lamp, NE-51	C221315-1	—	1
F6201 through F6204	Fuse	C221603-502	—	4
FL6201	Filter, Dressen-Barnes Model 21-105	A681997-1	—	1
C6205	Capacitor, 50 WVDC, 4000 uf	—	—	1
C6207	Capacitor, 50 WVDC, 4000 uf	—	—	1
C6209	Capacitor, 50 WVDC, 4000 uf	—	—	1
L6201	Choke, Dressen-Barnes 512910	—	—	1
R6201	Resistor, ohmite, 600 ohms, 5W, ±5%	—	—	1
FL6202	Filter, Dressen-Barnes Model 21-105	A681997-1	—	1
C6206	Capacitor, 50 WVDC, 4000 uf	—	—	1
C6208	Capacitor, 50 WVDC, 4000 uf	—	—	1
C6210	Capacitor, 50 WVDC, 4000 uf	—	—	1
L6202	Choke, Dressen-Barnes 512910	—	—	1
R6202	Resistor, ohmite, 600 ohms, 5W, ±5%	—	—	1
J6201	Receptacle, Box	—	MS3102R-18-12P	1
J6202	Receptacle, Box	—	MS3102R-20-7P	1
PS6201	Power Supply, Dressen-Barnes Model 21-103	A681999-3	—	1
C6201	Capacitor, 50 WVDC, 4000 uf	—	—	1
C6203	Capacitor, 50 WVDC, 4000 uf	—	—	1
CR6201	Diode, 1N2129, International Rectifier Type X25HB10	—	—	1

TABLE 6-II. LIST OF REPLACEABLE ELECTRICAL PARTS FOR DUAL POWER SUPPLY, P/N R651470-2 (Cont.)

Reference Designation	Part Name and Description	Bendix Part No.	Part No. (MIL, JAN, or FSN)	Quan.
CR6203	Diode, 1N2129, International Rectifier Type X25HB10	—	—	1
CR6205	Diode, 1N2129, International Rectifier Type X25HB10	—	—	1
CR6207	Diode, 1N2129, International Rectifier Type X25HB10	—	—	1
F6205	Fuse, 10 amp	—	—	1
R6203	Resistor, 1000 ohms, 5W, ±5%	—	—	1
T6201	Transformer, Dressen-Barnes 511721	—	—	1
PS6202	Power Supply, Dressen-Barnes Model 21-103	A681999-3	—	1
C6202	Capacitor, 50 WVDC, 4000 uf	—	—	1
C6204	Capacitor, 50 WVDC, 4000 uf	—	—	1
CR6202	Diode, 1N2129, International Rectifier Type X25HB10	—	—	1
CR6204	Diode, 1N2129, International Rectifier Type X25HB10	—	—	1
CR6206	Diode, 1N2129, International Rectifier Type X25HB10	—	—	1
CR6208	Diode, 1N2129, International Rectifier Type X25HB10	—	—	1
F6204	Fuse, 10 amp	—	—	1
T6202	Transformer, Dressen-Barnes 511721	—	—	1
XDS6201	Light, Indicator	C221313-7	—	1

TABLE 6-II. LIST OF REPLACEABLE ELECTRICAL PARTS FOR DUAL POWER SUPPLY, P/N R651470-2 (Cont.

Reference Designation	Part Name and Description	Bendix Part No.	Part No. (MIL, JAN, or FSN)	Quan.
XF6201 through XF6204	Post, Fuse, 3 AG	A683967-1	—	4

TABLE 6-III. LIST OF REPLACEABLE ELECTRICAL PARTS FOR INTERCOM PANEL, P/N R654990-6

Reference Designation	Part Name and Description	Bendix Part No.	Part No. (MIL, JAN, or FSN)	Quan.
DS6401	Buzzer, WECO, P/N 7F-42	A683505-1	—	1
R6401	Resistor, Dual Potentiometer	A683378-1	—	1
Z6401 through X6404	Key	A683775-1	—	4
	Associated Parts			
	Connector and Cable Assembly	A683543-1	—	4
	Connector	A683542-1	—	1

TABLE 6-IV. LIST OF REPLACEABLE ELECTRICAL PARTS FOR MISCELLANEOUS ITEMS

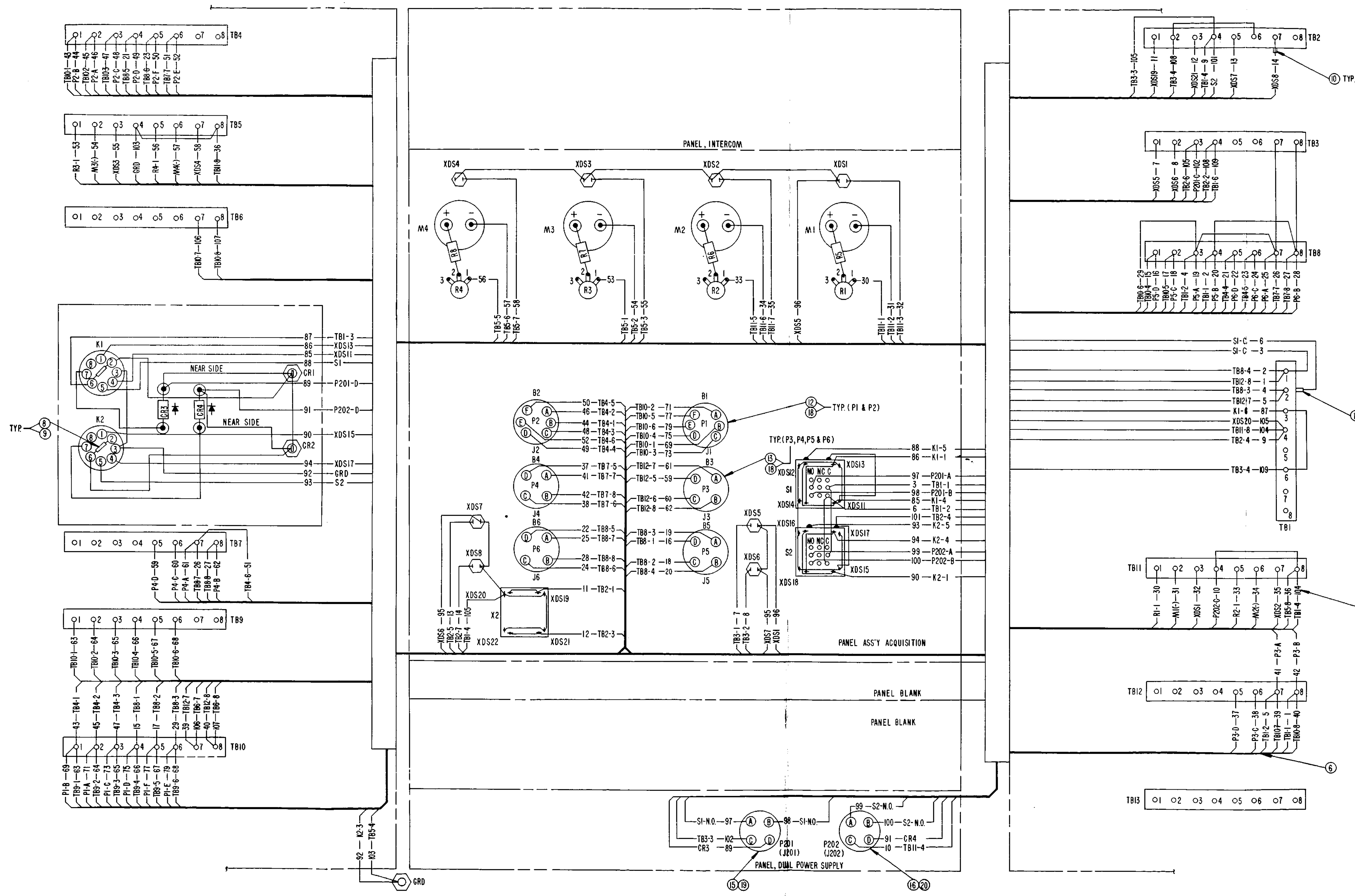
Reference Designation	Part Name and Description	Bendix Part No.	Part No. (MIL, JAN, or FSN)	Quan.
	Switch, cutoff w/warning light assy., consisting of:	L653858	—	1
	Switch and box, ERTA 12022	A683229-1	—	1
	Warning light assembly	A683135-1	—	1
	Lamp, Incandescent	A120680-1	—	1
	Cable	689846-2	—	—

SECTION VII
MAINTENANCE DRAWINGS

7-1. GENERAL

The drawings included in this section are listed below. It should be noted that those schematics which show connections or circuits involving two or more separate pieces of equipment are not in all cases complete in regard to the internal circuits of the equipment. For complete internal circuits, see the schematics of the individual pieces of equipment. The schematics of individual pieces of equipment are included in this section or in the individual equipment manuals, listed in table 1-II.

Figure 7-1. Acquisition Data Console, Schematic Diagram



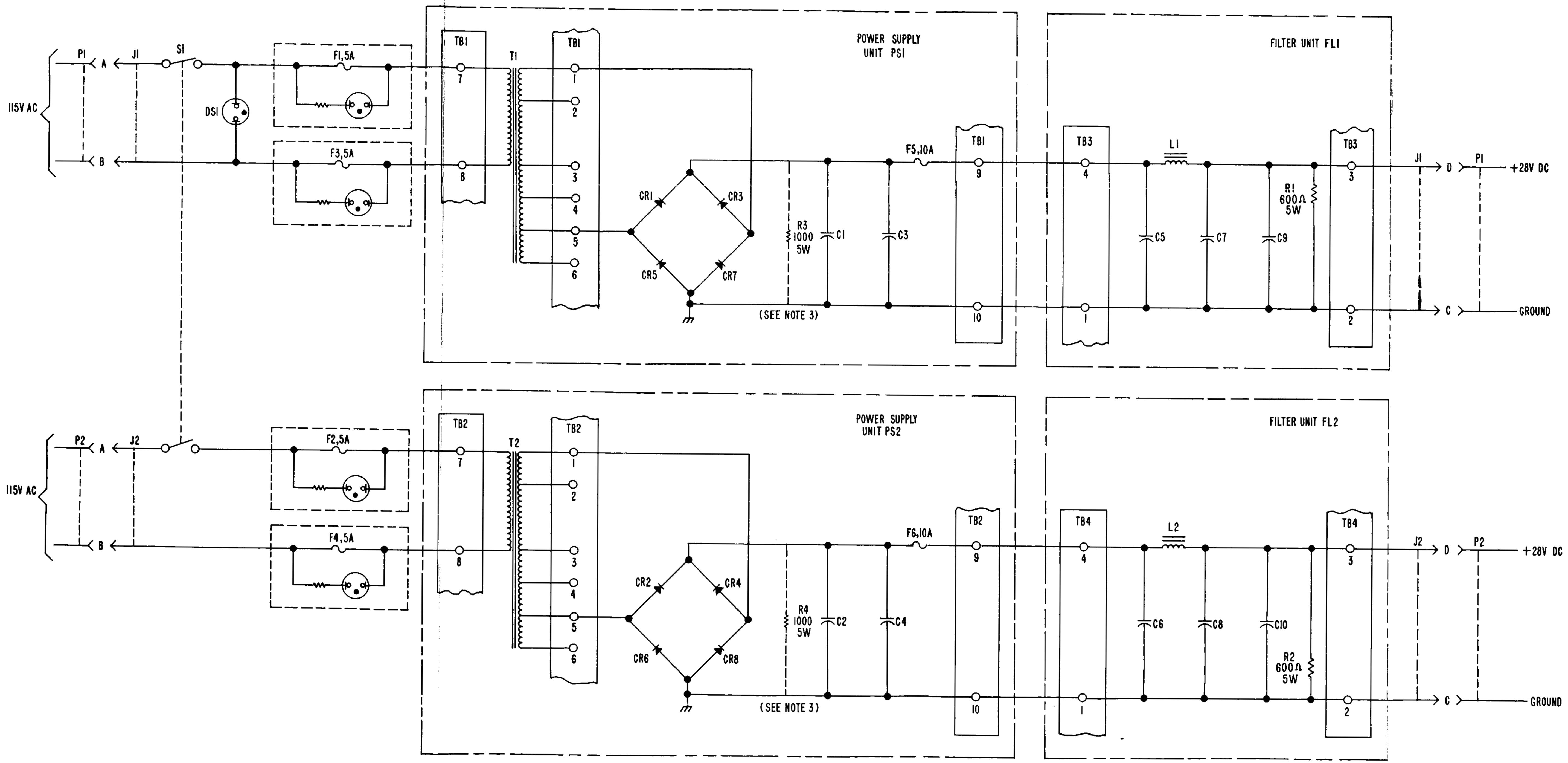
NOTES:

1. ADD 6000 TO ALL REFERENCE DESIGNATIONS IN THIS UNIT.
2. ALL WIRES BREAKING OUT OF CABLES TO BE ONE INCH LONGER THAN NECESSARY WITH EXCESS WIRE DRESSED IN A NEAT LOOP ADJACENT TO TERMINALS.
3. UNLESS OTHERWISE SPECIFIED ALL WIRES ARE WHITE #18 (ITEM 7).
4. SECTION REFERENCE DESIGNATIONS OF SWITCHES S1 AND S6 ARE AS FOLLOWS:

NO NC C
A
B
C

5. ATLANTIC OCEAN SHIP USE ITEM 21 FOR R5 THROUGH R8.
INDIAN OCEAN SHIP USE ITEM 17 FOR R5 THROUGH R8.

Figure 7-2. Acquisition Data Console, Physical Wiring Diagram



NOTES:
1. ADD 6200 TO ALL REFERENCE DESIGNATIONS IN THIS UNIT.
2. ALL CAPACITORS ARE 4000 UF 50VDC.
3. BLEEDER RESISTORS R3 AND R4 NOT USED ON SOME MODELS.

Figure 7-3. Dual Power Supply, Schematic Diagram

NOTE:
ADD 6200 TO ALL REFERENCE DESIGNATIONS IN THIS UNIT.

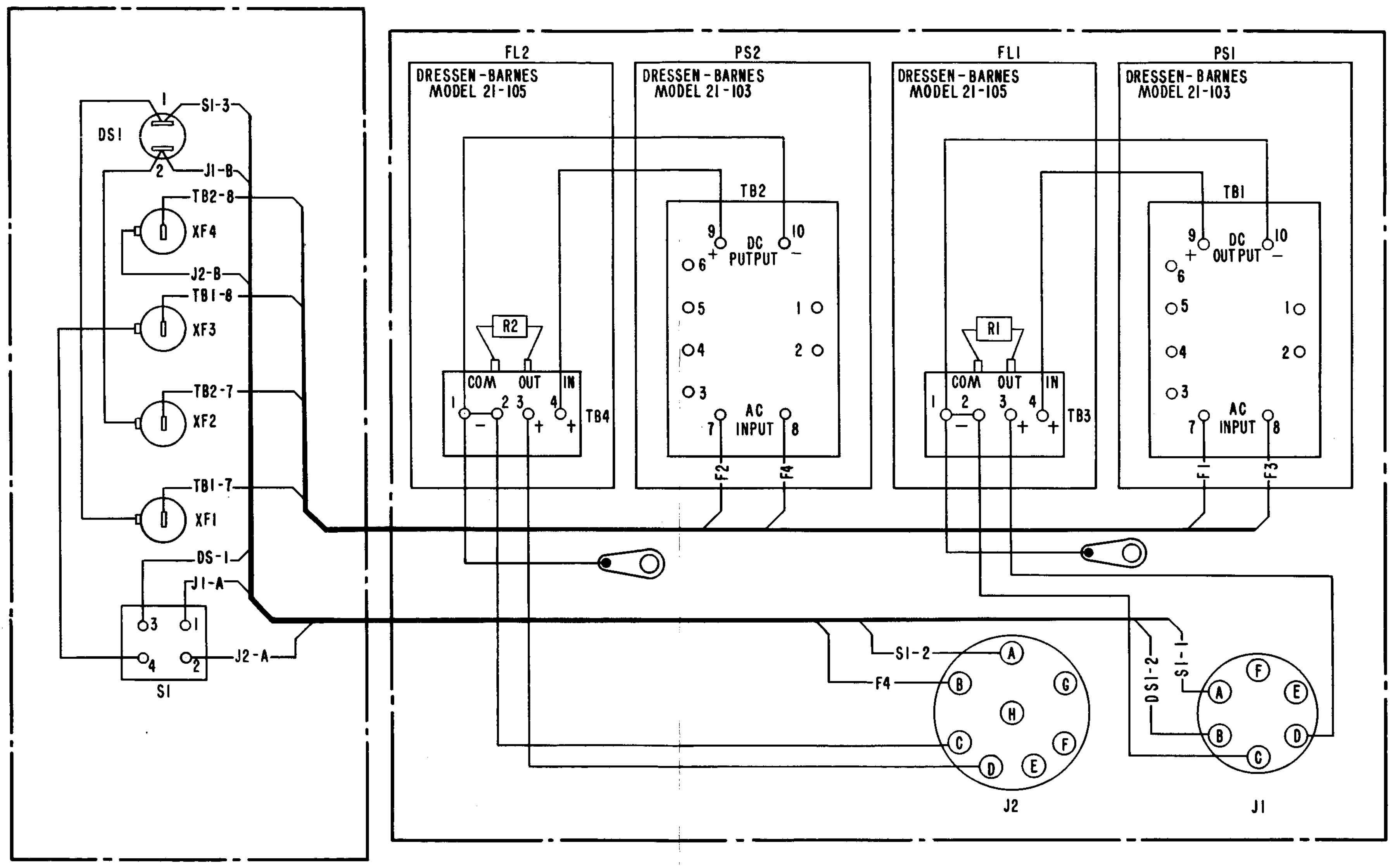
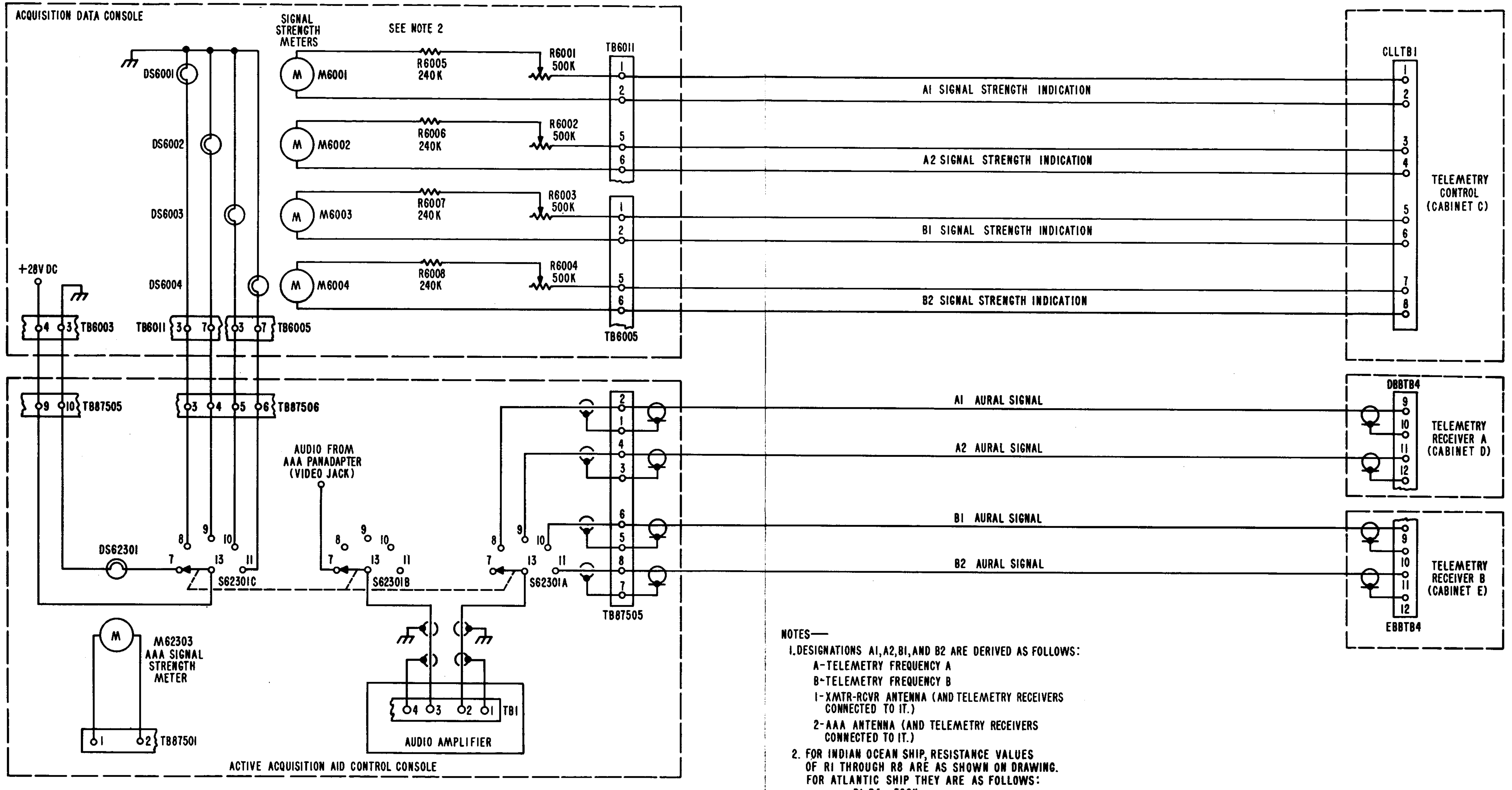


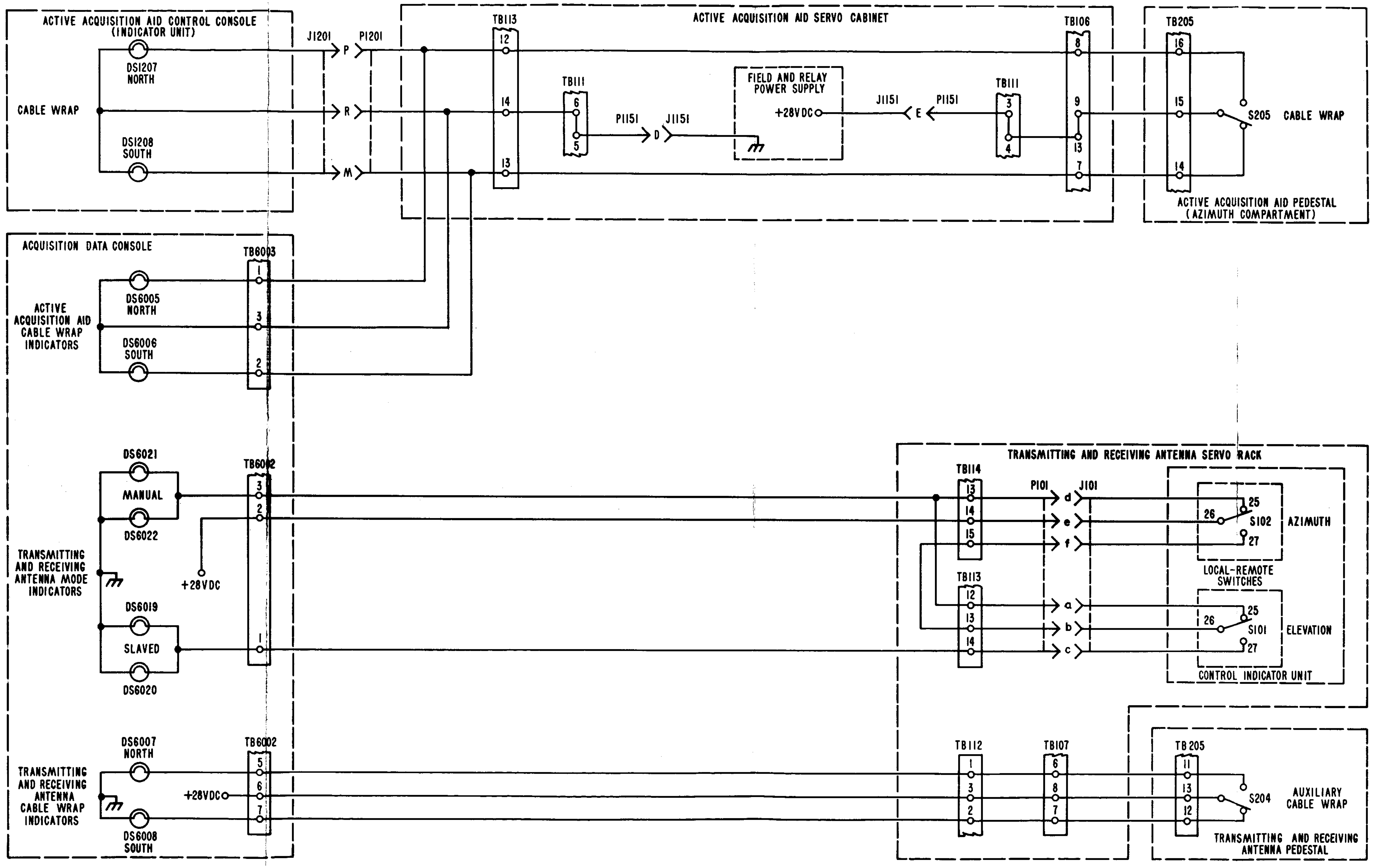
Figure 7-4. Dual Power Supply, Physical Wiring Diagram



NOTES—

1. DESIGNATIONS A1, A2, B1, AND B2 ARE DERIVED AS FOLLOWS:
   - A-TELEMETRY FREQUENCY A
   - B-TELEMETRY FREQUENCY B
   - 1-XMTR-RCVR ANTENNA (AND TELEMETRY RECEIVERS CONNECTED TO IT.)
   - 2-AAA ANTENNA (AND TELEMETRY RECEIVERS CONNECTED TO IT.)
2. FOR INDIAN OCEAN SHIP, RESISTANCE VALUES OF R1 THROUGH R8 ARE AS SHOWN ON DRAWING. FOR ATLANTIC SHIP THEY ARE AS FOLLOWS:
   - R1, R4 – 500K
   - R2, R3 – 1 MEG
   - R5 THROUGH R8 – 220K

Figure 7-5. Signal Strength Indication and Audio Monitor Circuits, Schematic Diagram



NOTE—

1. LOCAL CABLE WRAP INDICATORS ON TRANSMITTING AND RECEIVING ANTENNA SERVO RACK ARE OPERATED FROM 6.3VAC BY SWITCH S203. THE LOCAL INDICATOR CIRCUIT IS INDEPENDENT OF THAT SHOWN ON THIS DRAWING. REFER TO EQUIPMENT MANUAL.
2. TRANSMITTING AND RECEIVING ANTENNA LOCAL-REMOTE SWITCHES SHOWN IN LOCAL (MANUAL) POSITION.

Figure 7-6. Acquisition System D-c Indication Circuits, Schematic Diagram

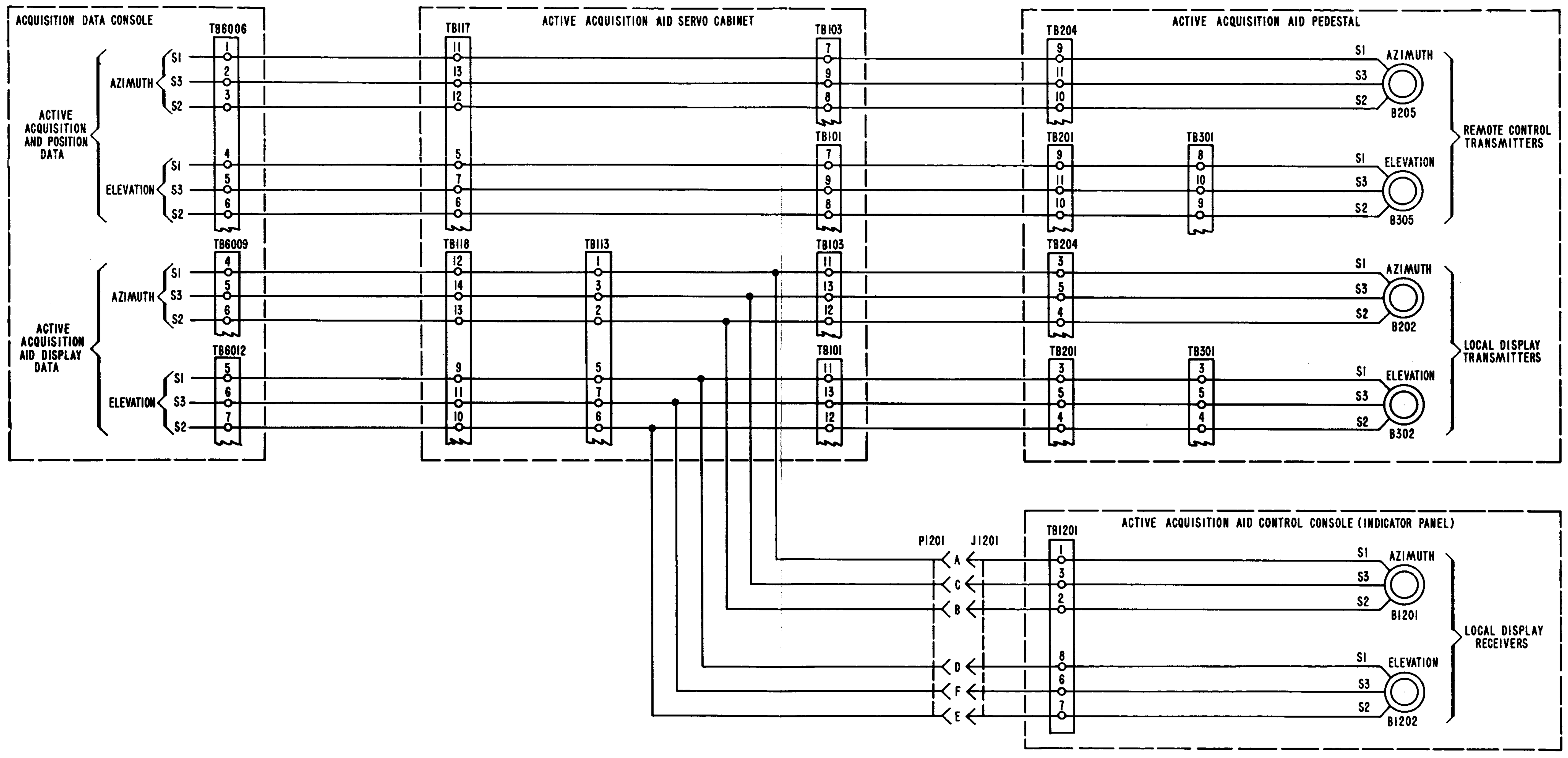


Figure 7-7. Synchro Stator Circuit Connections between Active Acquisition Aid and Acquisition Data Console, Schematic Diagram

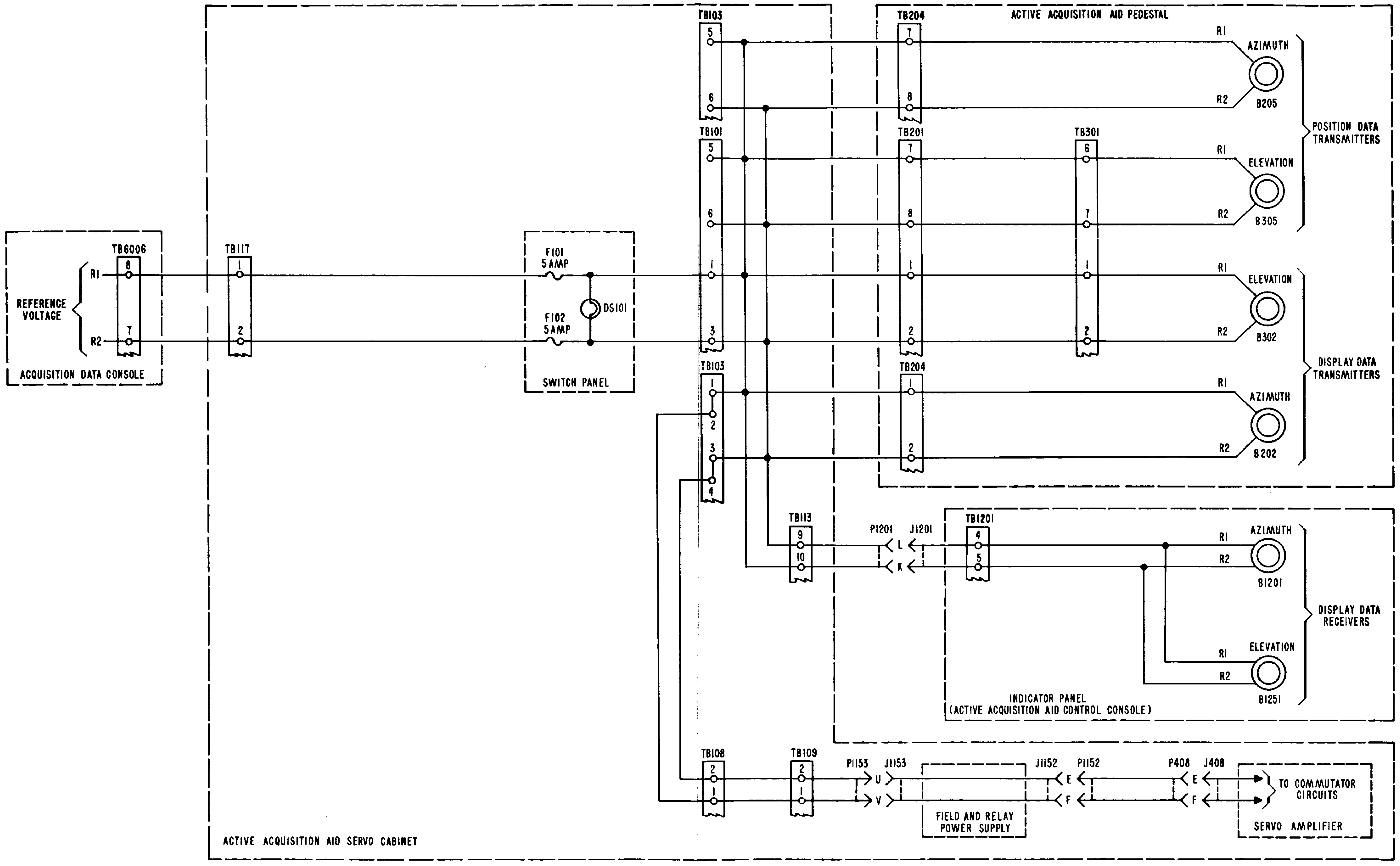
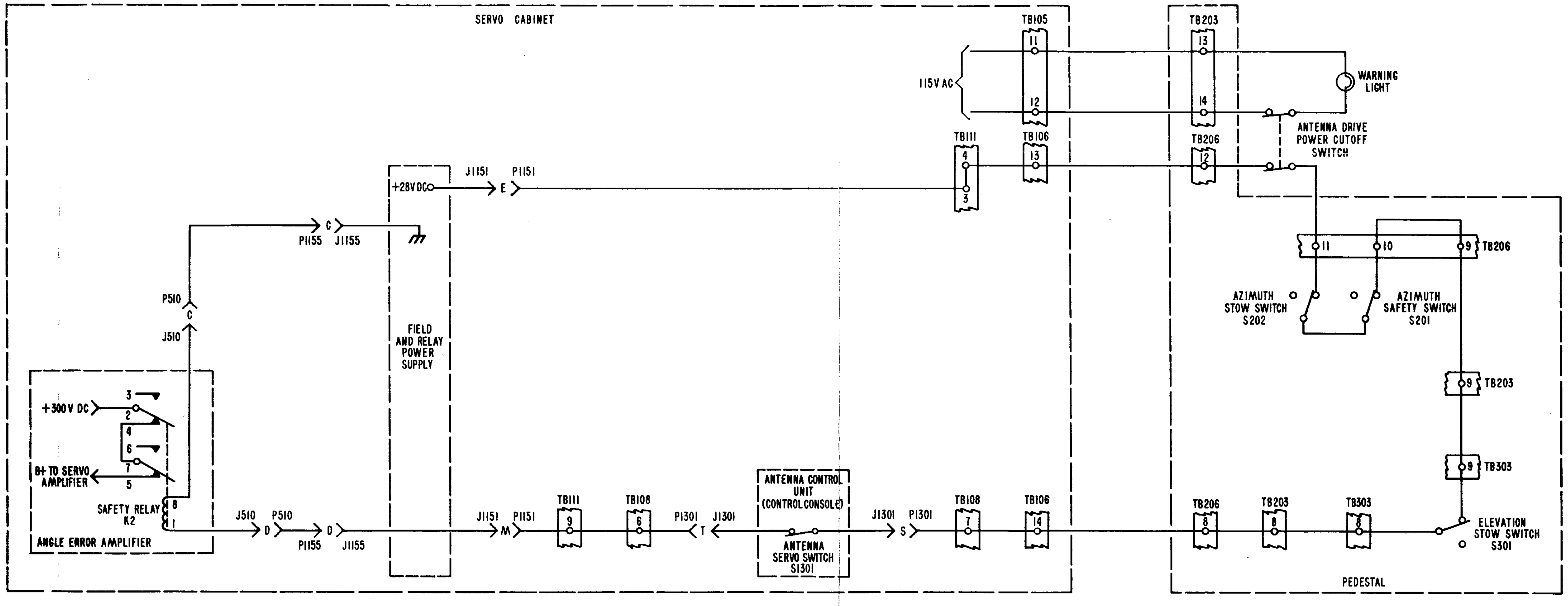


Figure 7-8. Synchro Reference Circuit Connections between Active Acquisition Aid and Acquisition Data Console, Schematic Diagram



NOTES—
1. ALL SWITCHES SHOWN IN RUN (OPERATING) POSITION.
2. RELAY SHOWN IN ENERGIZED POSITION.
3. ANTENNA DRIVE POWER CUTOFF SWITCH AND WARNING LIGHT (ONE ASSEMBLY) ARE MOUNTED NEAR TOP OF LADDER LEADING TO ANTENNA PLATFORM.

Figure 7-9. Active Acquisition Aid Antenna Safety Circuit, Schematic Diagram

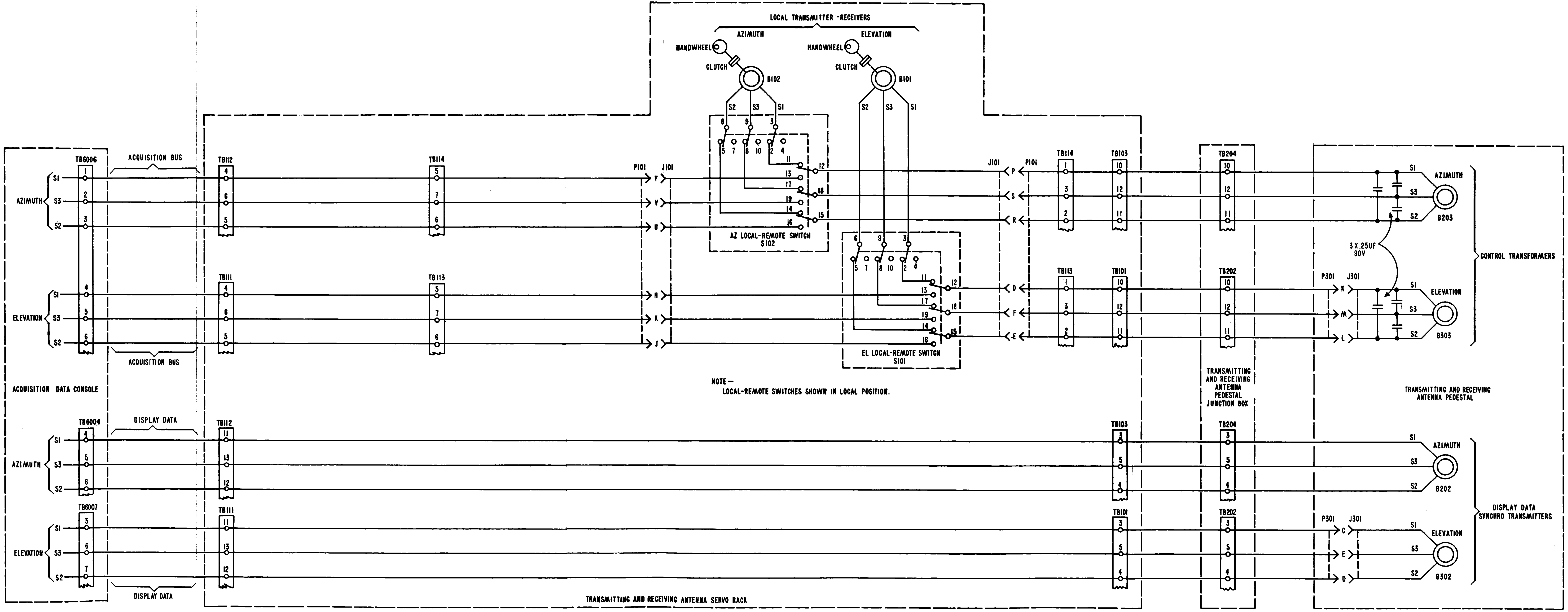


Figure 7-10. Synchro Stator Circuit Connections between Transmitting and Receiving Antenna and Acquisition Data Console, Schematic Diagram

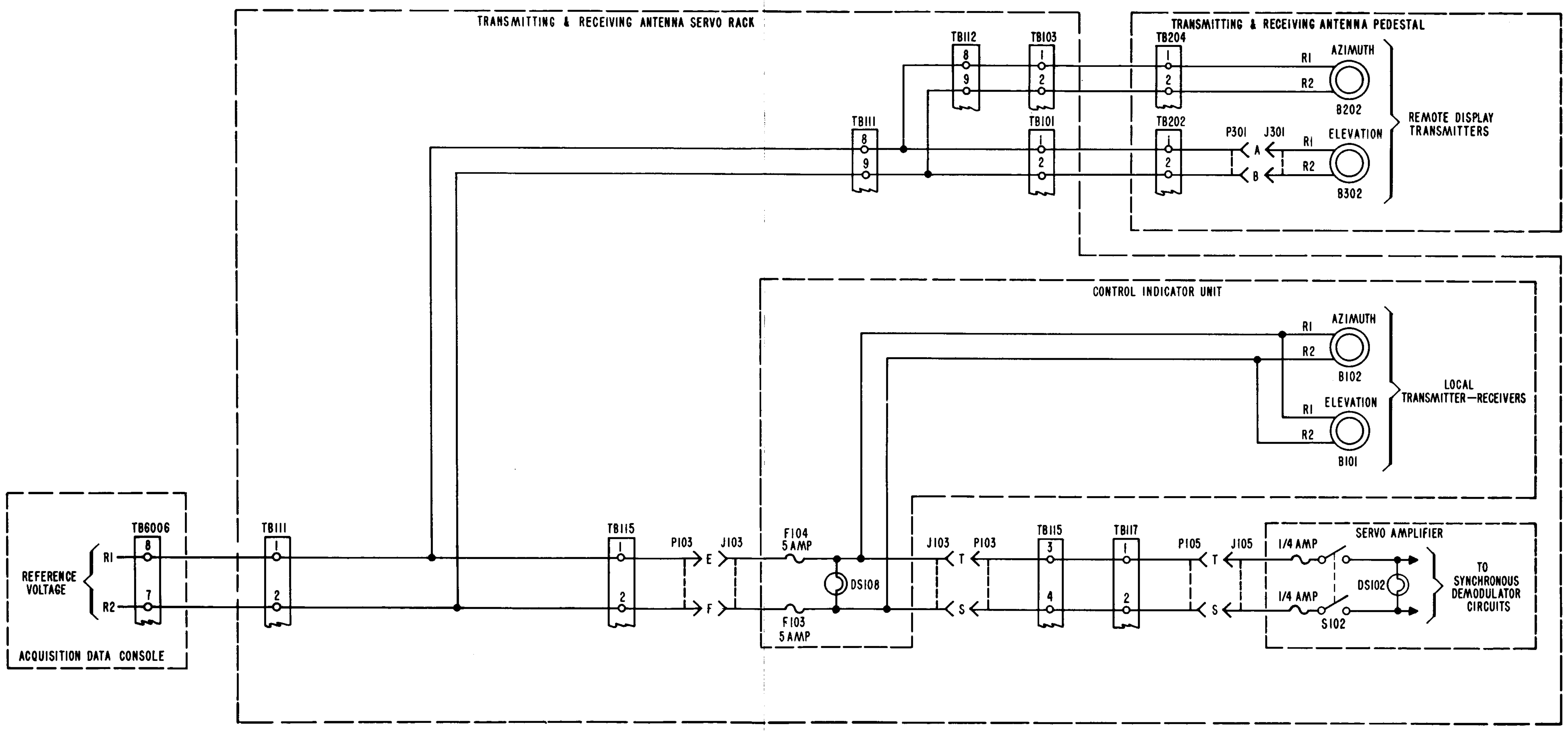


Figure 7-11. **Synchro Reference Circuit** Connections between Transmitting and Receiving Antenna and Acquisition Data Console, Schematic Diagram

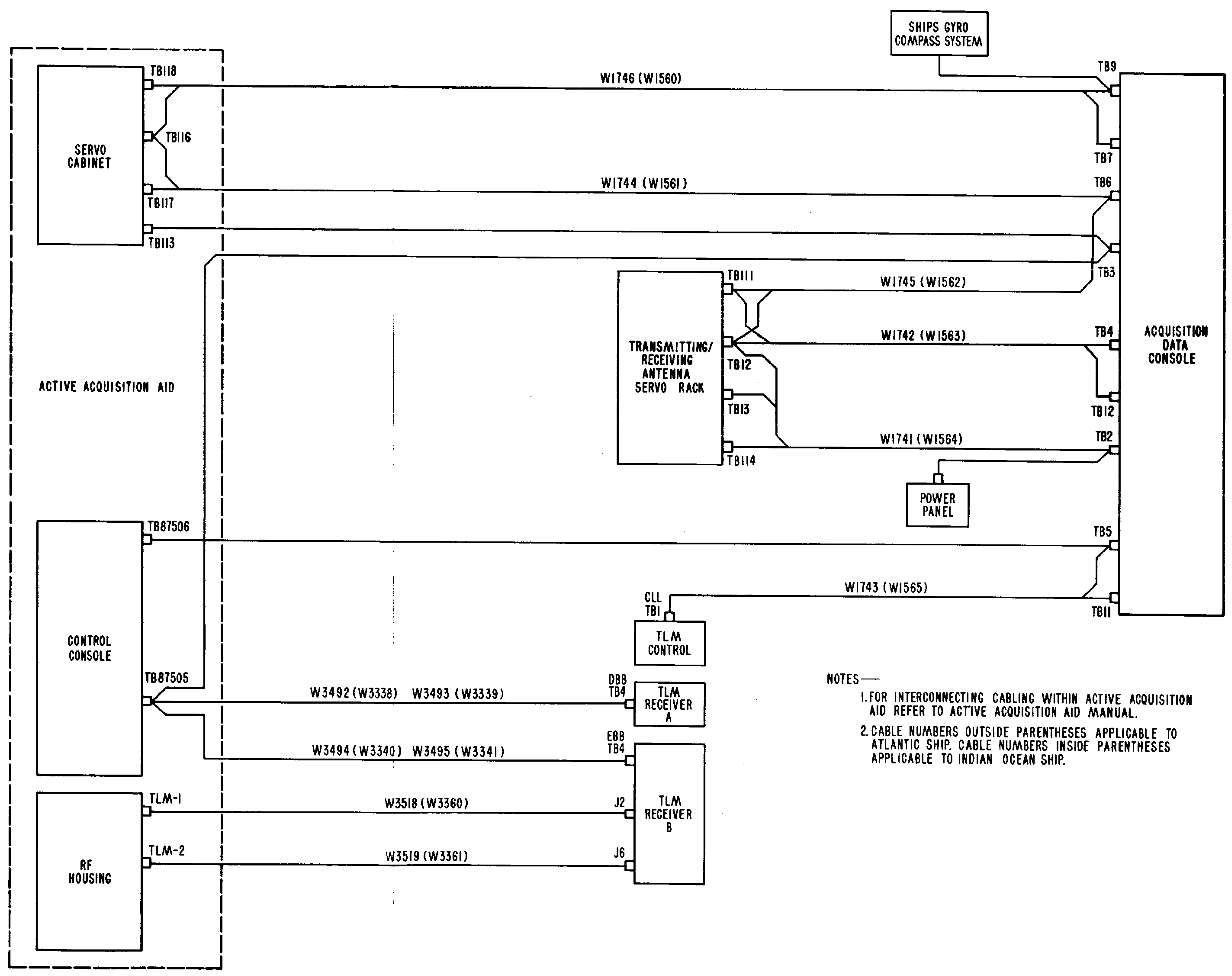


Figure 7-12. Acquisition System. Interconnecting Cabling Diagram